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JUNE - 1931

Electrical Features of a New Steel Mill

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Practices That Mean Safety

Getting Greatest Service from Controls

High-Pressure Lubrication

A McGraw-Hill Publication
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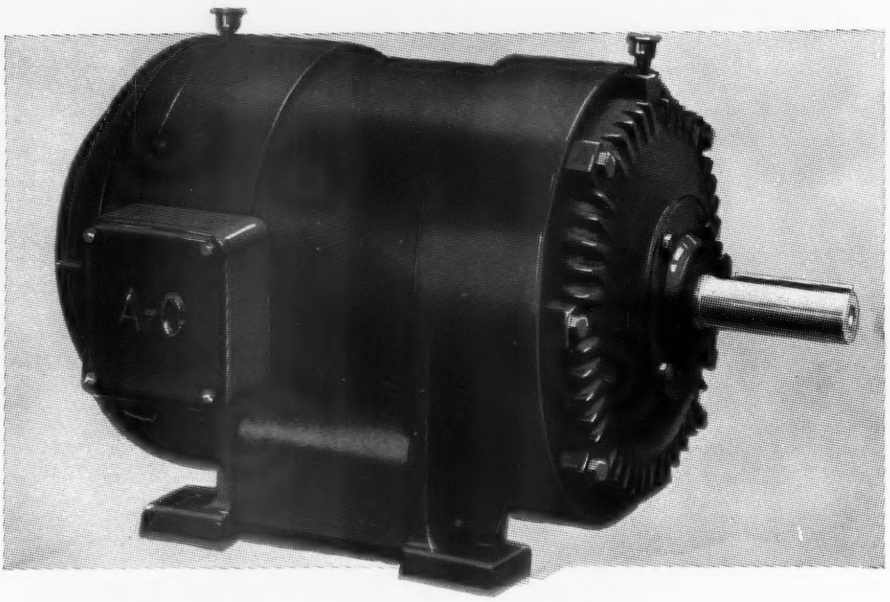

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MAINTENANCE ENGINEERING

A McGraw-Hill Publication, founded 1882

JUNE, 1931

Electrical Features of a Large Beam Mill Installation

R. H. WRIGHT
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THERE was recently installed at a steel-producing plant in the Middle West a complete new mill, designed to produce wide-flange beams. In this installation it was necessary to provide for rolling heavier sections at higher tonnage rates than previously used. It was, therefore, necessary to utilize more powerful electric drives than have ever before been used in the steel industry. The magnitude of the electrical system and a number of novel features make this installation of unusual interest.

The electrical equipment installed consists of 30,000 hp. of main roll drives, 22,000 kw. of 700-volt motor-generator capacity for supplying reversing motors, and the necessary transformers, and other equipment, including a.c. and d.c. auxiliaries.

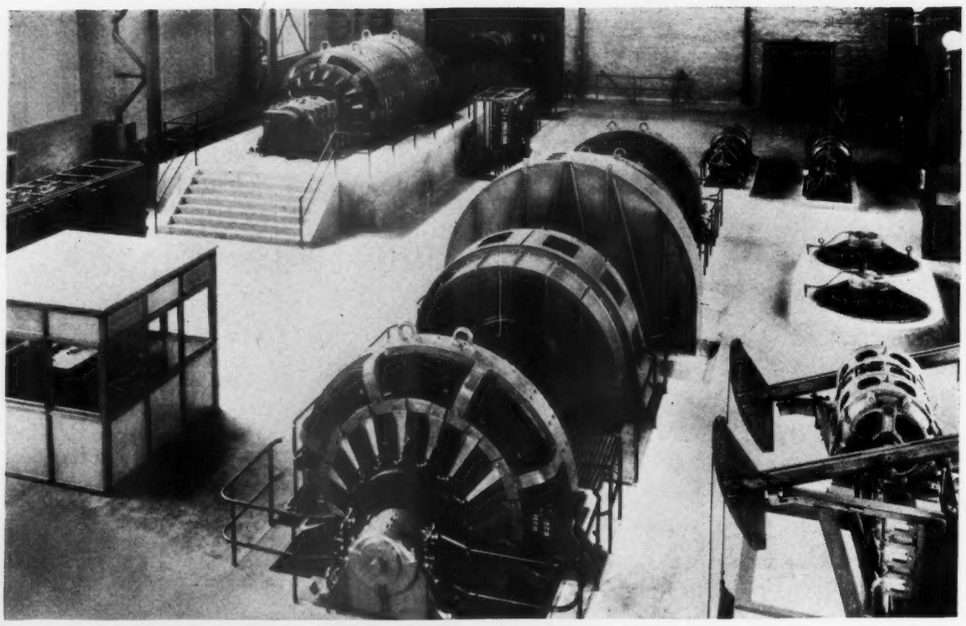
The accompanying system diagram shows the arrangement of circuits to connect the installation to the existing 22,000-volt system. A 15,000-kva. transformer bank located in the 52-in. mill substation provides 2,200-volt power for both the 54-in. and 52-in. mill stations. Three 40-kva., 400-amp., 0.8 per cent, single-phase, current-limiting reactors were installed in the primary side of the transformer bank and three 50-kva., 2,000-amp., 2 per cent, single-phase reactors in the 2,200-volt lines where a tie connection was made to a nearby transformer bank. Use of these reactors materially reduces the short-circuit current at the 54-in. and 52-in. mills, permitting the use of considerably smaller and less costly circuit breakers, and lessens the effects of short circuits on the rest of the system.

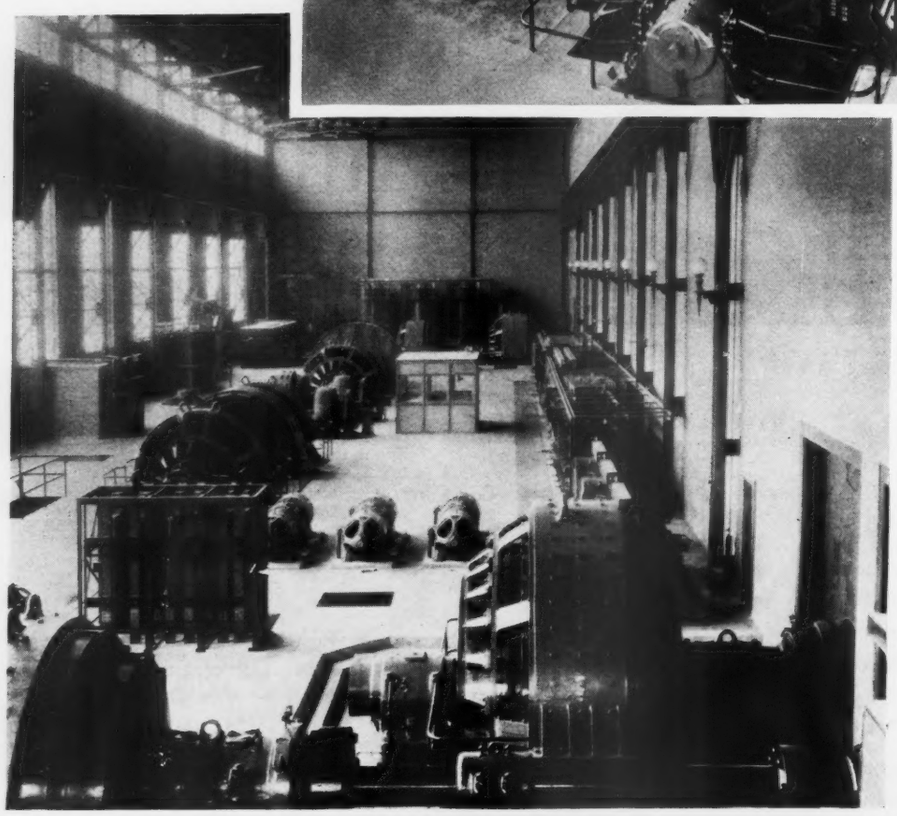
At each mill there are a number of auxiliary drives, such as pumps, air compressors, and shears, which are too large for the 440-volt circuit. These motors are connected to an auxiliary bus supplied from the main station bus through a current-limiting reactor. This arrangement makes it possible to use much smaller circuit breakers for the larger auxiliary drives and still retain the advantages of 2,200-volt distribution.

The main 2,200-volt circuit breakers are all mounted in steel trucks, and the smaller, auxiliary breakers in stationary steel cubicles.

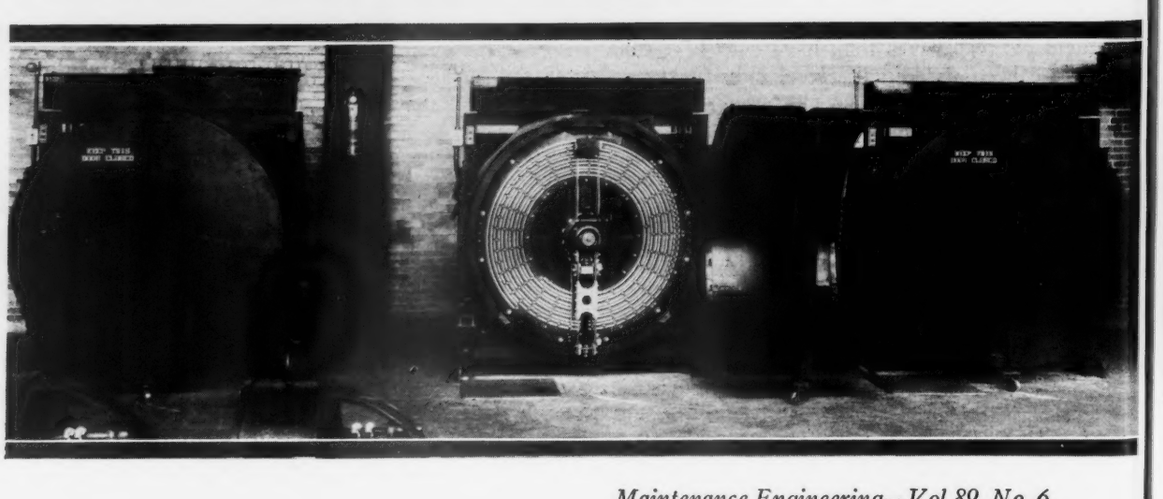
Ingots weighing from 30,000 to 50,000 lb. are rolled to beam blanks in a 54-in. blooming mill. Study of the rolling schedules indicated that the drive for this mill should have approximately 60 per cent greater torque capacity than provided for any previous mill. Ordinarily the upper and lower rolls of a reversing mill are driven by a single reversing motor through pinions. For the extremely high torques required by the new mill the pinions would be expensive and difficult to design. The design of a single reversing motor of the re-

The 54-in. blooming mill motor room, with 10,000-hp. twin motor, in the left background, flywheel motor-generator, and slip regulator (in the foreground). Note the vertical, propeller-type ventilating fans at the right of the motor-generator. This is the first installation of twin-motor drive, and the most powerful blooming mill drive, in this country.





In the 52-in. beam mill main sub-station, containing a 15,000-kva. transformer bank, the main drives for the 52-in. roughing and intermediate mills, and the automatic screwdown control. The 7,000-hp. and 2,000-hp. motors and 7,000-kw. flywheel motor-generator for the 52-in roughing mill appear in the background. In the foreground are the 6,000-hp. and 2,000-hp. motors and 6,000-kw. synchronous motor-generator for the 52-in. intermediate mill. The three variable-voltage motor-generators for the screwdown drives are between the intermediate mill motors and the 6,000-kw. motor-generator.



quired capacity also presented a number of problems.

It was decided to use two motors, one to drive the lower and the other the upper roll. Two motors, each rated 5,000 hp. at 40 r.p.m., with a combined maximum-peak torque capacity of 3,940,000 lb.-ft. were selected. This is the heaviest power that has been applied to a single pair of rolls, and the first time the twin-motor principle has been applied to a main roll drive. These motors receive d.c. power at 700 volts from a flywheel motor-generator consisting of three 3,000-kw. generators, a 6,500-hp. induction motor, and a 90-ton, steel-plate flywheel.

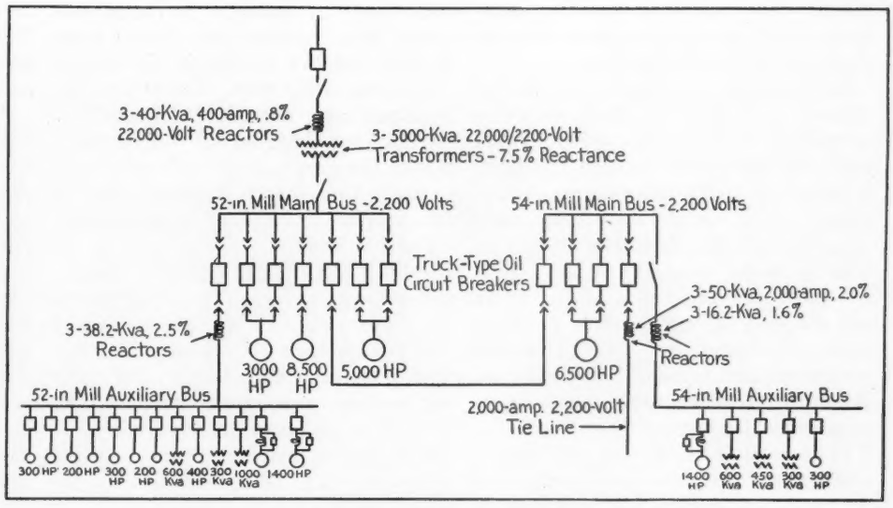


Diagram of main circuits for 54-in. and 52-in. beam mills.

Although the twin-motor drive was used principally to simplify the mechanical features and eliminate pinion losses and maintenance, it has been found to have very valuable operating advantages. It is very rapid and smooth in operation, resulting in much less shock on the mill, higher operating speeds, and greater tonnage output possibilities.

Beam blanks from the 54-in. blooming mill go to a 52-in. roughing beam mill driven by a 7,000-hp., 50/120-r.p.m reversing motor and a 2,000-hp., 57/163-r.p.m. reversing motor. These motors receive power from a 7,000-kw. flywheel motor-generator consisting of two 3,500-kw. generators, a 5,000-hp. induction motor and a 70-ton, steel-plate flywheel. This equipment is of standard design except that provision is made for maintaining correct speed and load relations between the two motors under a wide range of conditions.

Both motors work on the steel at the same time, drive rolls of different diameters, and must have their speed relations compensated to take care of variations in reduction on the steel. A special system of excitation is provided to take care of these conditions. The load consists of a series of comparatively short peaks which, if reflected directly to the a.c. power system, would cause considerable line disturbance. Hence, the motor-generator supplying power for this mill has a flywheel and slip regulator control.

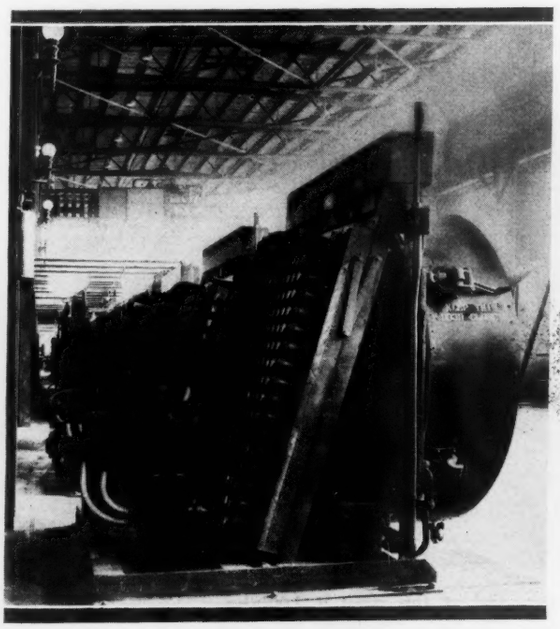
The drive for the 52-in. intermediate mill is similar to that for the roughing mill except that provision has been made for a different load condition. The rolls are driven by a 6,000-hp., 60/120-r.p.m. motor and a 2,000-hp., 75/225-r.p.m. motor. Owing to the length of the beam the passes are so long that a flywheel would be of little assistance in equalizing the load. So the intermediate mill motors receive d.c. power from a 6,000-kw. synchronous motor-generator, consisting of two 3,000-kw. generators and an 8,500-hp., 90 per cent power factor synchronous motor.

The synchronous motor-generator has the advantage of a somewhat lower first cost, and has higher efficiency, because of the inherently better efficiency of a synchronous motor and the elimination of flywheel losses. Power factor correction was not an important consideration, as the plant power factor could be maintained at a high value by other synchronous apparatus.

This motor-generator is started from the a.c. end by means of a reactor connected in the neutral of the primary windings during the starting period. This arrangement gives the simplest possible control, and very smooth acceleration. It is impossible to tell, without watching the instruments very closely, just when the motor is in synchronism and the field applied.

The starting inrush is about twice the full-load current, which is no greater than nominal load peaks.

The roughing and intermediate mills each have three pairs of rolls that must be set in the proper position for each pass. Roll settings are made by means of automatic screwdown controllers. Each screwdown drive consists of a shunt-wound, mill-type motor connected to a variable-voltage generator and an automatic controller having a limit switch with a plug board on which the desired roll positions are set up. The variable-voltage system of control was employed in order to get the desired accuracy and simplicity. Its use eliminates, among



Automatic screwdown limit switches with synchronized, remote electric drive.

others, the armature-shunting contactors and resistors required to give slow speeds for fine settings.

Elimination of armature-shunting control overcomes the difficulties due to stalling of the motors under abnormal friction loads caused by cold weather or faulty lubrication. Acceleration and deceleration are very smooth, and the rates can be varied over a wide range by very simple adjustments. The screwdown motors are stopped by regenerative braking, thus eliminating dynamic braking contactors and resistors. The solenoid brake merely holds the motor in position after the setting has been made. The use of variable-voltage control also greatly simplifies the connections in the limit switch and other automatic control features.

To function properly the limit switch must move exactly in syncronism with the screwdown motor, so that its position always bears a definite relation to the position of the mill rolls. The connection can be made either mechanically or electrically. With mechanical connection the limit switches are usually located out in the mill and connected by shafting with the screwdown mechanism. The limit switches take up valuable space, however, and the shafting interferes with the cranes in moving rolls and other equipment, and makes it difficult to change mill housings.

In the new installation the complete roll housings can be removed when rolls are to be changed; so the screwdown limit switches are driven electrically and are located in the motor room, out of the way. The mill pulpit locations are, therefore, determined not by the limit switch connections but by the needs of the mill operators.

Each limit switch drive consists of two special, three-phase, wound-rotor induction motors; one is geared to the limit switch and the other to the screwdown motor. The secondaries of these two motors are connected solidly together electrically, and the primaries are excited from the same three-phase auxiliary power circuit. The three-phase primary windings of these motors provide superior torque characteristics, as compared with the usual single-phase primaries.

The 52-in. finishing mill is driven by a 3,000-hp. synchronous motor. This motor is also started by reduced voltage, using a reactor in the neutral of the primary winding.

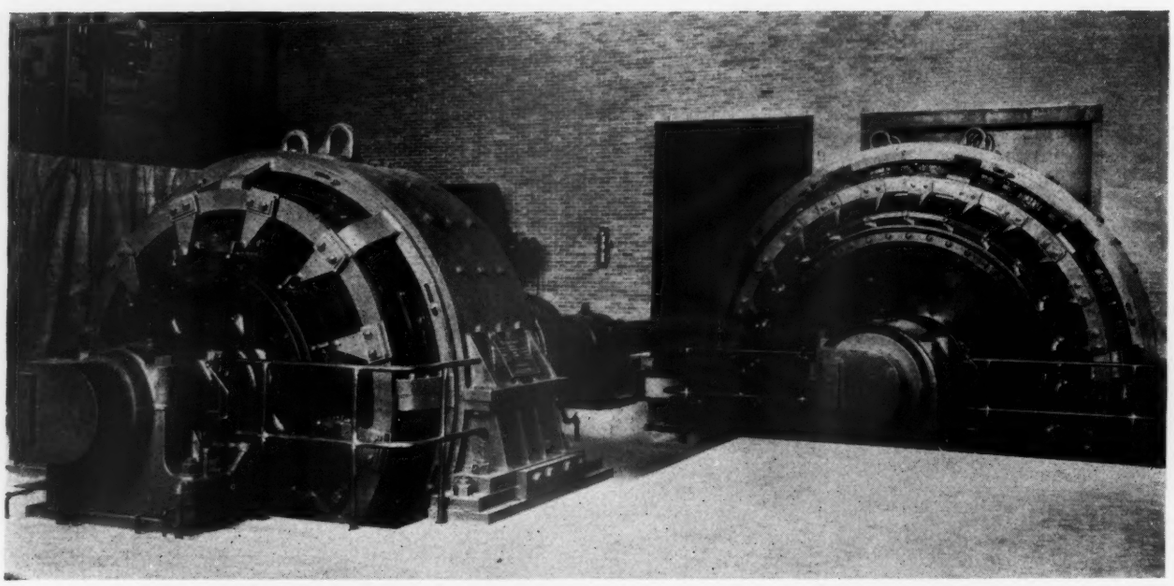
A closed system of ventilation is used for all equipment in the main substations. A small amount of outside air is drawn into each motor room through air mat filters, keeping the substation under positive pressure. This air makes up for the leakage through walls and windows and helps to carry off any excess moisture. Air for ventilating the electrical equipment is drawn from the room by vertical, propeller-type fans and forced through air coolers in compartments below the floor, from whence it passes to the machines. This is the first installation of propeller-type fans for this class of service.

Vertical fans have the advantage of being visible to the motor room operators and occupying a minimum of floor space. Properly designed propeller-type fans are considerably more efficient than standard centrifugal fans and, because of their high speed, they are very compact. In this installation all metal ducts are eliminated, with only air passages underneath the floor.

Exciters, fans, and other a.c. auxiliaries are driven by 440-volt, squirrel-cage motors supplied from the auxiliary 2,200/440-volt transformer banks. Motors of 25 hp. and less are started at full voltage. The larger motors are provided with starters that have one step of resistance in the motor primary circuit.

With the exception of the beam mill screwdowns, mill auxiliaries that operate intermittently are driven by standard 230-volt d.c., mill-type motors with standard mill-type rheostatic control.

It is interesting to note that the soaking pit covers at the 54-in. blooming mill are controlled from the pit crane, through photo-electric cells. One flash of light directed by the crane operator on a photo cell causes the corresponding pit cover to open. A second flash causes the cover to close.



At the left is a 2,000-hp. 57/163-r.p.m. reversing motor, and at the right a 7,000-hp., 50/120-r.p.m. reversing motor. These motors, which drive the 52-in. reversing roughing mill, operate in parallel in both directions of rotation, at any speed within their rated range.

. . . tools were under the watchful eye of Stewart McKinley.

Just for the fun of it—

Let's Check Back

See what it was like 50 years ago to keep a plant going. You'll say that maintenance has come a long way since then, and you'll get a better vision of where it's headed

The story is told by

BENJ. S. BURRELL

General Master Mechanic
Inland Steel Company
Indiana Harbor, Ind.

BACK in the 80's most of the time of the maintenance and repair department of steel mills was spent on repairing breakdowns and in keeping up steam pressure. In most plants shortage of water and dirty water kept the men of these departments on the go. In fact, a maintenance man in a steel plant was on the job not less than 12 hours a day, 7 days a week. Most of the time he worked about 15 hours a day and now and again took a 24- or 36-hr. turn.

The pioneering of steel plant machinery was a mighty hard task, and when one can visualize its magnitude he can understand why the progress along certain lines was very slow. It is not my purpose to belittle the pioneers in this line; as a matter of fact much credit must be given for their efforts, because they worked under great difficulties. Progress was slow not alone because they didn't know what was needed to make and keep the machinery right, but because in many cases needed tools and equipment were not available.

The men could not go to the toolroom window and ask for and get any kind of a tool they wanted. The toolroom as we know it wasn't in existence, and as certain tools were required they had to be sketched and made before the work could proceed. Often several tools of the same nature were made before a successful one resulted. Those were the days before the micrometer was known, and when a mechanic had to make his own kit of tools such as calipers, depth gages, surface gages, squares, and hand hammers. Possession of good tools was a matter of great pride, and a mechanic who could make a fine set of tools was considered a mighty valuable man and was looked up to by the average workman.

The Cleveland Rolling Mill Company, successor to the Chisholm & Jones Company, located in Newburgh, Ohio, now a part of Cleveland, was founded about 1860 to manufacture iron products from raw materials. This manufacture was carried

on until steel started to replace iron, say about 1870, at which time this company got started in the steel business, being one of the pioneers in the manufacture of steel rails, tie plate, and splice bar. The plant included blast furnaces; open hearths; Bessemer converters; blooming mills and finishing mills for rails, rods, and bars. There were hoop and merchant mills, also a wire mill in connection. This plant was purchased by the United States Steel Corporation about 1899 and since has operated under the name of the American Steel & Wire Company, Newburgh Steel Works Division.

Although established about 1860, up to the time of my employment in 1896 a good toolroom had not been established. However, there were certain hand tools, such as taps and dies; hand and socket wrenches; special templet gages, a few of which were in use; and a set of ring and plug gages starting at about 2 in. in diameter and advancing by half inches up to about 8 in. in diameter. These were all home made but fit fairly to each other and served fairly well for turning shafting and boring holes. They were made as needed and in about thirty years a fair number of sizes was on hand. Double hand chisels, flogging chisels, sledges, and steel wedges were kept in the machine shop foreman's office and in some small cupboards under the work benches outside of the office.

These tools were under the watchful eye of a man named Stewart McKinley, a very faithful but cranky old Scotchman. He laid the law down if we broke or lost a tool or failed to return the loaned tools. He kept no written record, depending altogether on his memory. He was never known to forget about giving out a tool and woe be unto the guilty offender.

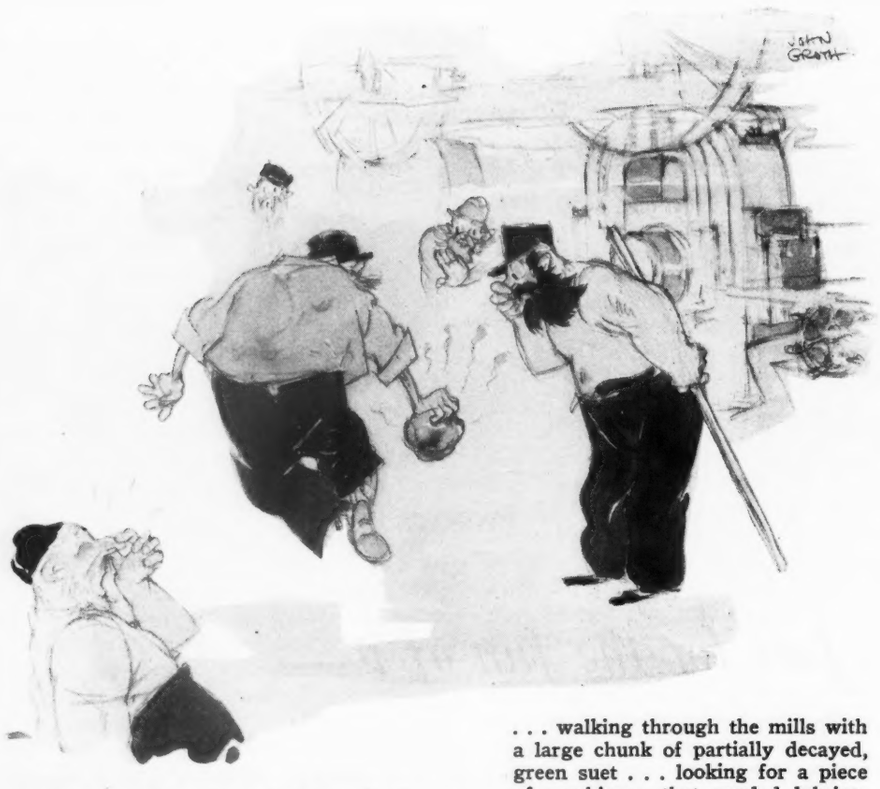
This man also took care of the work of lubricating, or oiling as it was then called, all of the machine shop lineshafting bearings. He was quite proud of his ability to do this work and could be seen going up and down the stairway all hours of the day with a long spouted oil can. He was obliged to leave the oiling job and give out tools whenever they were wanted and he wasn't in a very good humor when whistled on or called down from his oiling job to hand out a tool and he usually let us know it. He would not let anyone else do any oiling in his place. If he caught some one oiling a bearing that he was supposed to look after he made plenty of trouble. I recall old Stewart catching me upstairs oiling a lineshaft bearing and can hear him saying, "Awa' to hell oot of this, ye ken naething aboot lubrication." He had made a study of lubrication work and was a faithful and conscientious man at it and seldom was there a hot or wornout bearing due to his neglect.

Lineshaft bearings when given a fair amount of oil would give a good long life and could not be classed with the rougher type of mill machinery. However, all shop and mill auxiliary machinery such as straighteners, shears, punches, and reels was driven by lineshafts which furnished power to groups of machines. The prime mover in each case was a steam engine of home-made, simple design, mostly of the vertical type, in most cases of less than the required power, and naturally overworked to meet the power demand.

These numerous small steam engines required constant adjustment and heavy repair and maintenance to keep them going, and keeping them lubricated was quite an item, as in those days the circulating and splash systems were not in use and grease or oil cups served all wearing parts as best they could, which was poor at the best.

From the time of opening up this plant until 1882 the nationality of the workmen was principally Scotch, English, Irish, and Welsh. Past history gives Great Britain the credit for originating and developing the iron business and most of these workmen came from Great Britain as did the Chisholm family, who were the principal owners of this plant.

The different nationalities were di-



. . . walking through the mills with a large chunk of partially decayed, green suet . . . looking for a piece of machinery that needed lubrication.

vided in branches of the plant about as follows: The Scotch were the mechanics; the Welsh and English handled the iron and steel rolling work except in the rod mills; and the Irish the blast furnace, Bessemer steel works, and the rod mills. The Irish also handled the general labor until the strike of 1882, at which time some foreign laborers were put to work. They consisted mostly of Bohemians, who later got a good understanding of the various processes and got to doing the semi-skilled and finally the skilled work.

In 1885 another strike was encountered and more Europeans were employed; today the majority of the workmen are of foreign descent.

Lubrication of rolling mill machinery was taken care of as a matter of necessity. The biggest problem was the lubrication of the steam engine; next was the greasing of the roll trains. These two pieces of equipment received as much attention from the mechanical department of the mills as could be given, but at best this was very little, and almost no time could be spent by these men in developing ideas and methods for better lubrication.

It must be remembered that the oil and grease refineries were just developing, and that the constant demands by the steel people spurred them on to develop better lubricants, which were available later.

The grease house for the plant was located about in the center of the works and adjacent to the storeroom. It contained oils as follows: black, cylinder, sperm, lard, engine, and torch; and the following greases: hard and soft cup, axle, mutton tallow, soap, gear, and a large daily supply of suet. There was also plumbago which was used to a great extent.

This oil and grease house was presided over by an old Irishman by the name of Billy McKeon, whose appearance was in keeping with the dirty oil house. The only time he appeared different was when he went to church early every Sunday morning and it is safe to say he never missed a service, weather conditions never interfering, as his devotion in this line was as necessary with him as handling the grease house. He stood for no interference from anyone while on duty at the grease house, and, in fact, was such an important man in his line that he was often called out to the works at night to hand out grease and suggestions in times of trouble and distress, which were many in the early days. If he were asked what kind of work he did he always said, "I'm the greaser at the old mill." I often saw him conversing with Wilson Chisholm, who acted as general manager, so you may know that he was considered an important gentleman in his line.

Another old character who was an important factor in the greasing line in those days was Matty Coleman, who handled the delivery of oil and grease from the grease house to the brick rod mill and the new rod mill, as they were known. In appearance this old fellow also was in keeping with the product he handled, and he took no guff from anyone in his line. I have seen him bawl out Shoo Fly Thompson and Jack O'Donnell, who were superintendents in the rod mills, whenever they crossed his path in regard to the greasing of the two mills.

As well as delivering the oils and greases he was the party to apply most of it to the roll trains and he figured he was a past master at it and not a mere cub under instructions; he let anyone know how he felt mighty quick and plenty forceful. Suet was used as a lubricant on all roll train bearings in those days and I remember this old fellow walking through the mills with a large chunk of partially decayed, green suet in each hand looking for a piece of machinery that needed some of this material. It is easy to imagine the scent in the atmosphere when this kind of material was applied to a hot bearing on a hot day.

The electric light was not in use in the mill buildings in those days and it was quite a task daily at the grease house to pass out the necessary supply of torch oil, as every department had to prepare in the daytime for the lighting of the plant which was operated in all departments day and night. About half of the time of the grease house man was spent in handling this material and naturally the mill forces had to devote much of their time to preparing and keeping the torches lighted. The scent from them was discouraging to the workmen and in closed up shops in the winter months one's eyes were visibly affected by the smoke. Nothing need be said of the smell of one's clothing which was worn into the homes. However, it was a natural course to follow and was tolerated without much complaint by the working forces.

Much of the machinery in those days was operated by water pressure, or "hydraulic," as it was called. Jib cranes were in use in all departments. The smaller ones were of hand power, but the larger and more important were of hydraulic construction. All

. . . Pete Rusk spent half his time carrying oil and supplies from the works and applying them to the pumps.

large shears were of hydraulic construction with intensifier on each unit. They were extremely hard to keep packed and tightened up, also difficult to lubricate. This equipment required the constant attention of the best mechanical executives and workmen in the plant.

Ingot strippers also were of hydraulic construction and were fine equipment for this work, but like all machinery of this class were hard to keep lubricated and in constant operation. Lubrication was accomplished by swabbing the plungers with tallow which in many cases was made by rendering down suet in a kettle. Each department had a good supply of tallow pots and good-sized daily portion of suet. This material made a good lubricant for parts working in water as it had a penetrating effect and wouldn't wash off. It was also used to grease the hydraulic operating valves of all this class of machinery and is still used in this day for same purpose; it gives effective service.

Hydraulic machinery generally was in use in all mill departments and the repair and maintenance forces were kept on the run to keep it in constant operation. Most of our hydraulic machinery was designed and built by the user as were many of the pressure pumps, which also called for long hours of labor to cover breakdowns and repairs on week ends. Some of the pumps, known as the Martin pumps, were designed by Edwin Martin, one of the plant master mechanics who served in this capacity from about 1870 to 1890. They were double-decked affairs with the steam reciprocating engine above and the pumping compartment below. Two crank shafts were used, one for the engine and one for the pump and the transmission of power from engine to pump was delivered through a pair of gears, one on each shaft.

They were a noisy operating outfit, tough to keep going, and kept the engineers humping to prevent leaks and maintain lubrication. Do what you might you couldn't keep the wear from constantly showing up. Naturally the more the wear the greater the noise and by Saturday each week they were a hard looking and mighty noisy outfit and many times looked like they wouldn't last the day out. However, they kept going year after year and did their part to keep the product moving; in fact, the plant main water supply was furnished by a couple of large Martin pumps in the Canal Pumping Station which was located on the old Ohio canal and Cuyahoga river about four miles from the steel plant.

. . . "Awa' to hell oot of this, ye ken naething aboot lubrication.

The engineer of this pumping station, a man by the name of Peter Rusk, worked about night and day to keep up the water supply. He rode back and forth from the station to the works in a horse-drawn buggy in the summer and wet season and in a sleigh in the hard winters. He was a fine-charactered gentleman and well liked by all the mechanical forces; a man more faithful to his employer could not be found. He could be seen daily and nightly going along the country roads from the works to the pumping station to his home. He always appeared about wornout and heart broken trying to keep this outfit operating. To add to his troubles a flood in the wet season would occasionally shut the outfit down. He would keep it going until the water would rise high enough to put the fire out in the boilers, by which time the pumps were operating half submerged and he and the other men employed had to leave the place in a row boat. When the flood waters started to cover the ground on the pumping station level Mr. Rusk would take his horse and buggy up on the hill back of the pump house to keep it on dry land.

I was sent with a half-dozen other workmen to repair a breakdown of one of these pumps at night during a flood period. We had to stop the wagon about a half mile from the pump house and wave a torch light and lantern as a signal to the pump house tender to come for us with a row boat, which arrived in about half an hour.

There was no railway connection to this station and the coal for boiler fuel was delivered by canal boat in the summer time. The steel plant mechanics handled the heavy repairs and breakdowns to this station and it was a job to ride back and forth with tools and machinery parts day and night to accomplish this task. I believe that Pete Rusk spent half his time carrying oil and supplies from the works and applying them to the pumps; shutdown was just about an unpardonable sin with little hope of redemption.

The telephone was not in use in the mills in those times and all communication between departments was done personally or by sending a messenger boy or an old man who was not able to do daily labor in his old or regular pursuit. The lack of the telephone caused a lot of lost motion; however, you don't miss a thing if you never have had it.

A loud and prolonged howl would go up if the telephone were taken away from us today. We'd yell just as loud if suddenly we were deprived of many of the other tools that we take as a matter of course.

Sometimes I feel that there isn't enough appreciation of the strides the maintenance departments have made, because the limelight has been focused on production work. When I get to feeling that way I wish that every maintenance man could look back with me to see conditions as they were 50 years ago.

PLANT ENGINEERS' FORUM

Here is the twenty-first of a series of questions, each of which has at least two sides. A new question will be presented next month, and our readers' answers to previous questions also will be published. Write down your opinions and send them to the editor. Answers published will be paid for at an attractive rate.

Initiative or Apathy?

George Shipman and Frank Fulleger are boarding different trains at the same station, Frank on his way home from the plant, George on his way "out of town." It is the day after an evening meeting of the local organization of maintenance engineers.

* * *

"How was your meeting, Frank? Did you make a good presiding officer? Bring out the discussion? Keep 'em awake? Drag everything out of the subject? And what was the subject, anyway?"

"Hey, wait a minute—give me a chance. It *was* a fine meeting, in my opinion, though I may be prejudiced because I presided and because I suggested the topic. Don't know whether we got everything out of the subject or not, but I had to halt things at 10:30 with everybody going strong. All of that sounds pretty good, doesn't it?"

"Yes, it does. And the subject?"

"Stated fully, George, it was this: 'Should the maintenance engineer initiate proposals for the purchase of new equipment, or modification of existing equipment, in order to bring about a reduction in the operating costs of the plant, or should he merely follow instructions?' I referred to it as boiling down into, 'Initiative or Apathy?'"

"What were the conclusions?"

"It wasn't a debate, George. We didn't have any judges. I suppose that each man made his own conclusions in the light of what was said plus his own experiences."

"How about a trend, then? Didn't more people talk on one side than the other?"

"No, I guess talk was about equally divided, but certainly I was more impressed by the men who endorsed initiative. As a group they overshadowed the fellows who felt that it was up to them to take what they were given and make the best of it. In other words, the men favoring initiative gave the impression of having plenty of it."

"And yet it's a characteristic of the animal 'man' that, many times, the more forceful he is in shouting for something the weaker he is in making use of it after he gets it."

"Well, even discounting the oratory about 50 per cent——"

"Guess you'll have to discount it a hundred, Frank—here comes my train. Sorry—. See you next week."

* * *

Here IS a mess. Why, they didn't even bring out a single point on either side. How argue against them or with them? That's easy. Think the thing out for yourself—give your own uninfluenced opinion.

Initiative or Apathy?

(Answers to previous questions start on the following page)

READERS' ANSWERS

to previous questions

Who Orders Repair Shutdowns?

(Question presented in the May issue)

WHEN a discussion arises in regard to the necessity for a repair shutdown, I believe that the following plan would be a satisfactory basis for a ruling. All work of the maintenance department necessitating shutdowns should come under one of two classes. In the first class should come those jobs that, if not done quickly, would endanger human life. The maintenance engineer's word should be absolute and final on all work of this class. All work affecting production and which, if postponed, would not endanger life, should comprise the second class. Decisions for shutdowns in this class should be left to the management, after both sides of the problem have been presented by the maintenance engineer and the production superintendent respectively.

Shutdowns often could be avoided by employing more men on night work. When a machine has to be overhauled entirely, much of the work could be done "bit by bit" at night, leaving the final shutdown for the week-end.

ALFRED C. LAYZELL
In Charge of Production Inspection
Sipp, Eastwood Corporation
Paterson, N. J.

THE responsibility for ordering repair shutdowns falls upon the maintenance department as part of its preventive maintenance program. Many variables must be considered before putting a machine or unit out of commission. The nature of these factors is such that the head of the maintenance department cannot shut down equipment indiscriminately without co-ordinating with his superiors and the department heads involved. The answer often is that repair or overhaul must be put off until some future date, even though the job may cost many times more when it is finally done. There are exceptions to this stand, of course, such as are occasioned by safety or other emergency measures.

Customers' orders are the life blood of any industry. Rather than jeopardize the good will of customers, it is at times more expedient to delay much-needed repairs—even though contrary to efficient maintenance.

In cases in which a battery of equipment is involved and power is purchased, it may be advisable to delay such repairs to suit minimum and peak power demands, according to the rate requirements of the power company. If this factor were not considered, the money lost in paying for unsued power might be much greater than that gained by taking advantage of immediate repairs. In such a case, arrangements should be made so that the load is properly balanced for the shutdown at the earliest possible date. Likewise, careful planning is necessary in determining when to shut down many types of continuous-process or straight-line equipment to avoid tying up a whole department or plant. Probable changes in equipment due to variations in demand or other economic conditions also have a bearing on shutdowns. These conditions and forecasts often are known only to the management. Under such conditions, the maintenance department must act according to the judgment of its superiors.

H. L. SCHULTZ
Assistant Superintendent of Maintenance
The Carborundum Company
Niagara Falls, N. Y.

FROM the maintenance engineer's point of view there is but one answer to the question—he should order repair shutdowns when necessary as part of preventive maintenance. If some one higher up should interfere, the responsibility for the inevitable result of a breakdown or other damage would, of course, rest upon him.

At our plant, experience has taught us to heed the judgment of the maintenance man. During one of the rush periods in our punch press department, the die setter reported that the bearings and guides of a certain press had become so worn that the press was shearing the dies. But the foreman would not allow the maintenance men to shut down the press long enough to repair it, claiming that production schedules would not permit it and that he thought it would operate satisfactorily until things were not so rushed. Consequently, in attempting to operate the press when equipped with one of our large dies, the tools sheared and roughed so that the die became jammed, not only cracking the die but also springing the crank shaft. Results: a broken die, a ruined crank shaft, and production held up just the same.

CHAS. H. WILLEY, *Assistant Plant Superintendent*
Hoyt Electrical Works
Pennacook, N. H.

DESPITE the fact that the maintenance engineer usually is best acquainted with and best qualified to give advice concerning the repair or overhaul necessitating a shutdown, there are times when considerations other than efficient maintenance are paramount. At times it is more important to keep production on schedule, even though eventually it results in a breakdown.

The proper procedure is for the maintenance engineer to report his recommendations to the production department and the management. Recommendations should specify what equipment should be shut down, when the work should be done, and how long it will take. If the shutdown will not interfere seriously with the production schedule, the production department should O.K. the proposed overhaul and, with the approval of the management, the work should proceed as recommended. However, if the production department does not consider the shutdown feasible, the management should decide the best procedure. Such decisions are the func-

tion of management—to coordinate the various activities of minor executives.

In the latter case, the maintenance department, being prejudiced in favor of the importance of its function, might feel that it was being put in second place but, like all other departments, it must expect to suffer occasionally for the greatest good of the plant. After all, the purpose of any business organization is to make profits and, to fulfill this purpose, the lesser of two evils occasionally must be chosen.

BERNARD SHEREFF, *Engineer, Standards Department*
American Hard Rubber Company
College Point, N. Y.

Should Maintenance Engineers Attend Conventions?

(Question presented in the April issue)

ONLY those maintenance engineers should attend conventions who honestly feel that they are to be benefited and are able to pass on the benefit to their companies. Conventions are, on the whole, an asset to any profession or industry, for it is only by association with others that we develop and expand.

My plan to improve conventions is this: Sectionalize them so that only one class of papers will be presented at each session, attendance at the session being limited to that group. For example, papers on painting or roof repair should not be presented in a joint session of the electrical and building maintenance departments, or vice versa; it would be a waste of time for one group or the other.

In the case of electrical conventions, the papers should be based on the results of a survey of plant and electrical engineers. A questionnaire should be sent out about a year ahead to determine the most important subjects of interest to the greatest number. The subjects of the papers to be read should be chosen in the order of the number of votes received. This set-up would eliminate a lot of unnecessary trips.

W. B. FERGUSON, *Works Electrical Engineer*
Westinghouse Air Brake Company
Wilmerding, Pa.

BECAUSE of my work of determining efficiencies and setting bonus standards on maintenance work, I have been able to see the benefits when the heads of such departments attend conventions.

In one plant where I was employed they were against any type of visiting or traveling to conventions by the executives. A new man, who was placed in charge of maintenance, went to a convention at his own expense. Soon after his return the standards department literally was swamped with calls from the maintenance department for studies to be made. The new man was making changes left and right, calling for new and better methods, which would save money.

After the management was apprised of the savings being made, and was informed by the head of standards work that he thought they had come about because of the contacts the maintenance man made while he was away, they did a right about face and started to order practically all officials to attend such meetings.

Of course such a thing easily can be overdone, but if judgment in selection is used nothing but good can come from the maintenance head's attending the convention.

CHARLES R. WHITEHOUSE, *Standards Engineer*
The Holtzer-Cabot Electric Company
Boston, Mass.

To Whom Should the Maintenance Department Report?

(Question presented in the March issue)

THE maintenance department should report direct to the management because it is an individual department of which the "repair gang" is only a part. The repair gang, when under the production department, makes repairs after trouble occurs. The duty of the maintenance department is not only to make repairs but also to prevent breakdowns by the employment of men trained and educated for this purpose. Other duties are the selection and installation of equipment which, in some cases, previously were the responsibility of outside engineers. In these cases the engineers reported to the management and not the production department.

With maintenance and production in separate departments there can be satisfactory results only when there is strong co-operation between them.

The production heads are specialists in their line but are not specialized in maintenance. Let the production department make its requirements known to the maintenance engineer. Let the maintenance engineer report to the management.

IRA A. DAVIS, *Maintenance Foreman*
Consolidation Coal Company
Fairmont, W. Va.

THE maintenance department should report directly to the management for the following reasons:

1. The training of a maintenance force, with its varied duties, requires greater time than is necessary to train machine operators. It is therefore harder to replace a good maintenance man than a machine operator. This difference in itself would increase the difficulty experienced by a production manager in handling two widely different classes of help.

2. Because of the diversity of its interests organization of a maintenance force is much different from that of most production departments. This difference alone necessitates delegation of maintenance supervision to one that is versed more in the duties of maintenance than those of production. This delegation of authority creates a separate division entitled to present its problems directly to the management.

3. Being represented as a department with the same privileges and responsibilities as other departments, the maintenance force can be expected to take more interest and pride in its work.

4. With production and maintenance functioning independently though working toward the same goal, the maintenance department is relieved of any over-lapping of duties.

5. Maintenance today is being recognized as a necessity, instead of an evil. Being a necessity, it should be given representation and recognition by the management.

BERNARD OTTING, *Maintenance Engineer*
The Cincinnati Milling Machine Company
Oakley, Cincinnati, Ohio

How Valuable Are Plant Visits?

(Question presented in the February issue)

BY all means visit as many other plants as possible, and see how the other fellow does it Result: valuable pointers, confirmation of your own ideas, or proof that you were wrong.

Every manufacturer has problems in common with others, irrespective of the lines engaged in; if you are observant, you will take back many mental photographs of just how you can lick those obstinate troubles in your plant.

I worked for a long time on a problem of straightening bars as they came from the rolls of a rolling mill; conditions were so bad that 50 per cent of the material was rejected as so crooked that it would not go through the guides of the presses.

There was nothing on the market that seemed to fit the case. In visiting a factory where an entirely different class of metal strip was made, I saw exactly the same problem handled in the easiest and simplest manner. In two minutes I had the idea; I immediately went back to my office and sketched just what we wanted. In a week the 50 per cent had been reduced to almost nothing.

I could describe many similar experiences, but could not say any more than this: Supplement your visits to other plants, as provided by *Maintenance Engineering*, by actual visits within your working radius, and use the results to convince your superintendent or manager that he should O.K. your expenses, charging them to research or to the acquirement of valuable knowledge pertaining to the business.

JOHN S. ISDALE, *Plant Engineer*
Factory K, International Silver Company
Meriden, Conn.

Bonus for Maintenance?

(Question presented in the January issue)

NO bonus long has been a sore spot with the maintenance department, especially when the production department is getting one.

It is feasible to pay a bonus on maintenance work. One system of which I know worked as follows: A minimum of production was arrived at, based on plant capacity. For every ton produced, over this figure, a bonus was paid, prorated over the payroll, each production man getting a bonus proportionate to his base pay.

For the salary list a cost against unit of production was determined, and for every dollar per ton saved there was a flat bonus rate set. By this means the maintenance men were made to realize that their efforts as well as those of the direct producers were responsible for higher production.

To measure the work of the maintenance department repair cards should be analyzed and the loss of time due to machinery breakdowns must be taken into consideration.

Records of relative costs of production and maintenance provide a sure way of finding out if the maintenance department is on the job. The remedy for not being on the job lies in the hands of the maintenance engineer. For example, he can see what motor repairs were caused by lack of lubrication. He himself has no alibi, because it is his responsibility to see that every factor governing such mishaps is taken care of, presuming that he has full say as to lubricants, bearings, lubricating devices, and all other important variables.

M. C. COCKSHOTT, *J. B. Gill Corporation*
Long Beach, Calif.

IN China, I believe, they pay a doctor to keep you well. Why not use somewhat the same method in paying a bonus on maintenance? The profits are made when every machine is running. Bonus checks come from profits. I would set aside a fixed amount each month to be divided by the maintenance gang if every machine has been kept running all month. For each machine idle because of a breakdown I would deduct a certain amount from the bonus.

Steam railroads give prizes to the supervisors having the best track at the time of inspection. What is a bonus but a prize for efficient work?

J. WALTER WRIGHT, *Assistant to the President*
Wilmot Fleming Iron & Steel Company
Philadelphia, Pa.

Who Shall Specify Equipment?

(Question presented in the October issue)

THE relation between the plant engineer and the purchasing agent should be one of hearty cooperation, with a complete understanding of the other's aims and problems. Each has his sphere of activity and each, if conscientiously filling his job, tries to do what in his opinion is best for the organization as a whole. The plant engineer has no more justification for getting peeved because the purchasing agent questions his specifications than has the purchasing agent if, in an emergency, the plant engineer verbally orders certain work done by outside contractors, and which is followed up later with a requisition for a confirming purchase order.

If the plant engineer could look through the purchasing agent's eyes for just a minute he would understand why the latter looks askance at an iron-clad requisition submitted without an explanation. The purchasing agent spends considerable time listening to the claims and counter claims of salesmen in dozens of lines; he becomes conversant with many claims for superiority of product and performance, and develops an uncanny ability to differentiate between rock-bottom facts and the many frills and furbelows with which these facts are so often bedecked in the salesman's talk.

When an iron-clad specification reaches his desk a red light flashes on his brain path. Seven times out of ten he is familiar with the item mentioned and can recall part of the many claims made for it by John Doe, the energetic salesman. He recalls that during a recent interview in which John was expounding its virtues, he was mentally comparing the product with that made by a competitor. So he looks on this iron-clad requisition as a challenge and proceeds to comb the market for "something just as good for less money."

To avoid any occurrence like that, it would be simpler for the plant engineer to anticipate requirements and take the purchasing agent into his confidence. Write or tell him that it may be possible to make a worth-while saving in a certain installation; point out to him, if such is the case, that so far no appropriation has been authorized by the management, but that complete information is desired so that an intelligent choice can be made, before submitting a recommendation.

Approached in this way the purchasing agent will endeavor to please and obtain data that will surprise you. Of course, it is possible and quite probable that the same data is in the files of the plant engineer all the time, but here's the difference—the purchasing agent didn't know it. Then, when the selection has been made and the authorization granted, the purchasing agent will go along with you because he knows that the claims of more than one manufacturer have been given consideration. It is rumored that there has been a case or two in which the purchasing agent actually succeeded in finding something better at a lower price.

E. G. GREEN, *Plant Engineer*
Libbey-Owens-Ford Glass Company
Charleston, W. Va.

BETWEEN the purchasing and maintenance departments the relation should be based upon mutual co-operation. It is very easy for one department to misunderstand another when both fail to recognize each other's importance in the organization. The duties of the purchasing department are to obtain from the outside market the necessary materials and supplies for maintenance, construction, and production.

To assist the purchasing agent to place requisitions to the greatest advantage the maintenance department should furnish complete information pertaining to the materials in question.

When the purchasing agent feels that the time specified for delivery is not sufficient for his purpose, he should confer with the one making out the requisition. In most cases this procedure will result in an extension of delivery time, thereby satisfying all concerned. Care should be exercised by those ordering supplies not to over do the customary requests with remarks such as "rush," and so on. It is much better to be specific.

The purchasing department should not be held to precise specifications any farther than good judgment and experience dictate, however, care must be exercised so that specifications are not too broad.

When the maintenance department considers it essential to change specifications it should confer with the purchasing department, giving reasons for the desired change. When the purchasing department is assured that it can do better by changing certain buying tactics, or by changing the sources of material purchases, it should confer with those whom the changes will affect.

All supplies pertaining to the maintenance department, except those of a general nature, should be specified by that department, and unless it has been consulted, the purchasing department has no right to change specifications. If the purchasing department has this authority trouble is sure to arise, with the result that the maintenance of equipment will suffer. Also, standardized lines of equipment and materials will be broken, making it necessary to increase the stores of spare parts.

In many ways the purchasing department can be of great assistance to the maintenance department. Very often expensive materials are used where cheaper ones would suffice. The maintenance department would have specified the latter had it known, or thought of them at the time of ordering.

For instance, platinum contact points were specified for an experimental device. The contacts first thought of were those of a voltage regulator, so they were specified without knowing them to be expensive. The purchasing department obtained a quotation on the contacts before ordering, and found that their cost was $55. With this information a suggestion was advanced that distributor points might answer the purpose. It was found that they would be satisfactory, and their cost negligible in comparison with the contacts first specified. MARIN PHILLIPS, *Electrical Superintendent*
International Paper Company
Niagara Falls, N. Y.

What Maintenance Policy During Depression?

(Question presented in the September issue)

DEFERRING maintenance during a depression is an expensive policy for any plant to adopt, for as conditions become stabilized materials will cost more and the need for replacement parts, by volume, increases as the period of deterioration is permitted to continue.

It is only natural for managers to curtail activities during depressions, where maintenance is considered as a direct overhead charge, but that does not justify the actions of those who are permitting entire plants to deteriorate because of a lack of confidence in the future.

Large institutions provide object lessons during a depression. They lay plans for new construction or execute plans made previously and engage a considerable portion of their personnel in construction and other necessary repair work. As conditions improve schedules can be met with equipment in first-class condition and experienced personnel to operate it.

There are tasks such as conveyor installations that can be done better when the plant is not in operation, that is, during a depression, and others that can be done conveniently, with the plant in operation. If more companies could anticipate such work it would be better to postpone only the major tasks until a slack period, and thereby smooth out the unemployment curve. K. D. HAMILTON, *Mechanical Department*
Geo. E. Keith Company
Campello, Brockton, Mass.

SAFETY ALWAYS-ALL WAYS
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31
NONE
MINOR
MAJOR
NO LOST TIME ACCIDENT FOR ___ DAYS
THIS WHITE CARD
CLEANLINESS
ORDERLINESS
EXCELLENT

Bulletin boards indicate safety debits and credits.

Safe Practices Mean Safety

W. L. SCHNEIDER

Safety Engineer, The B. F. Goodrich Rubber Company
Akron, Ohio

PROPER safeguards make for safe conditions about any plant, but having provided them it is too much to expect that the safety of the personnel is assured. Thus, in part, goes the conviction at the Goodrich Rubber Company, Akron, Ohio, that the greatest factor in safety is the ability to recognize hazards.

To illustrate, take the structural worker. Outside of safe slings there are few, if any, safeguards. The individual recognizes the existing hazards of his trade and performs his work accordingly, which without doubt is responsible for the comparatively low accident rate. An accident as a result of relaxed vigilance is usually fatal.

What about the plant worker? The electrician, for example, whose work is no less hazardous. Above 440 volts all power circuits are extremely dangerous, yet with proper safeguards accidents are frequent and oftentimes fatal. In most cases the cause is relaxed vigilance, and for other plant workers the same analogy holds. Take this plant which employs up to 16,000 workers in operations producing 32,000 different rubber articles, representing 1,000 distinct rubber products, and the extent of the safety problem becomes apparent. Add to that pertinent facts about physical property and the background is complete—65 separate buildings varying from 1 to 10 stories in height, providing a working area of approximately 6,000,000 sq.ft.; 60 elevators; 7 substations of which three are main stations, controlling incoming 23,000-volt power for 3,200 motors with capacities up to 1,000 hp.; 32,000 machines; 12,000 shears, and 15,000 knives. All motors, 150 hp. and above, are operated at 2,200 volts.

With the foregoing in mind, the accident statistics for three years, listed in the table on page 285, show what has been accomplished in safety work to the end that the workman shall live to enjoy the fruit of his labor.

An analysis of the safety setup reveals a simplicity of procedure that is far reaching in results, and to which is attributed an increase in all-around operating efficiency.

Contrary to the ordinary conceptions about safety, mechanical safeguards now in reality play only a secondary part where previously they were considered paramount. The reason for this is that from experience we have learned that no matter how well an industrial factory may be mechanically guarded, accidents still happen because of "man failure." Every precaution is taken, however, to see that adequate mechanical guards are provided in accordance with modern standards.

In construction and application they are not unlike devices of this character used in similar and other industries, safeguarding against known hazards with which plant personnel has long been familiar.

Among these commonly known devices are belt and gear guards, guard rails, safety stops, limit switches, in-

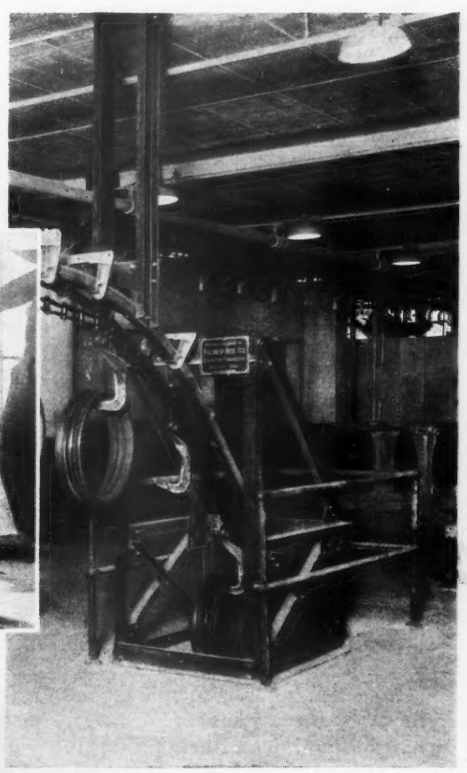
closed control panels, shatter-proof glasses, dust masks and other gadgets, also motor control that permits plugging in, bringing ponderous masses such as mills to a stop within a few inches of travel. For explosive atmospheres, explosion-proof equipment is used and so on down the line, all contributing to a necessary function for practical safety.

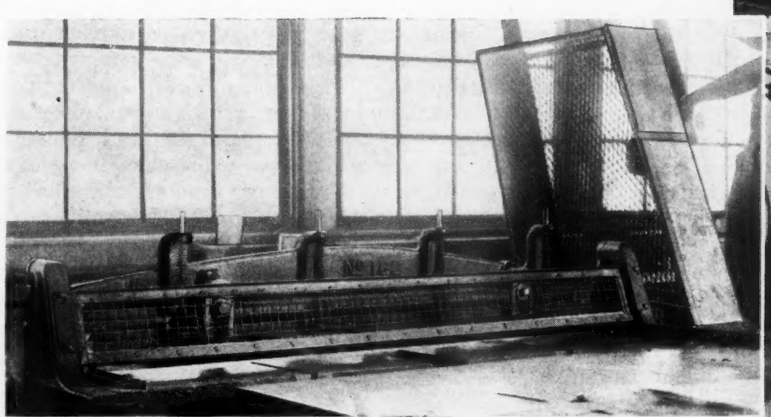
Therefore, going back to 1921 and for several years previous, the personnel of the safety department consisted of a force of 18 people whose duty it was to see that mechanical safeguards were applied, and safety inspections regularly made in all departments. In fact they assumed nearly all of the responsibility in connection with accidents and mechanical safeguards. Departmental foremen and so on up the line were relieved of all efforts in this direction until a retrenchment program was instituted. Up to this time a smug complacency existed to the extent that conditions pertaining to safety were as good here as anywhere, in fact they were no worse, even though it was realized that the safety message was not reaching the workers. Accidents continued and many represented recurrences which pointed out that the workers were also permitting the safety personnel to assume their share of the vigilance.

Doomed by retrenchment, the safety department personnel was reduced to one man, the safety engineer, whose duties resemble those of a liaison officer. Direct responsibility for safety was placed upon department heads who delegated their foreman subordinates and inspectors as safety supervisors responsible for the slightest accident occurring in their respective departments.

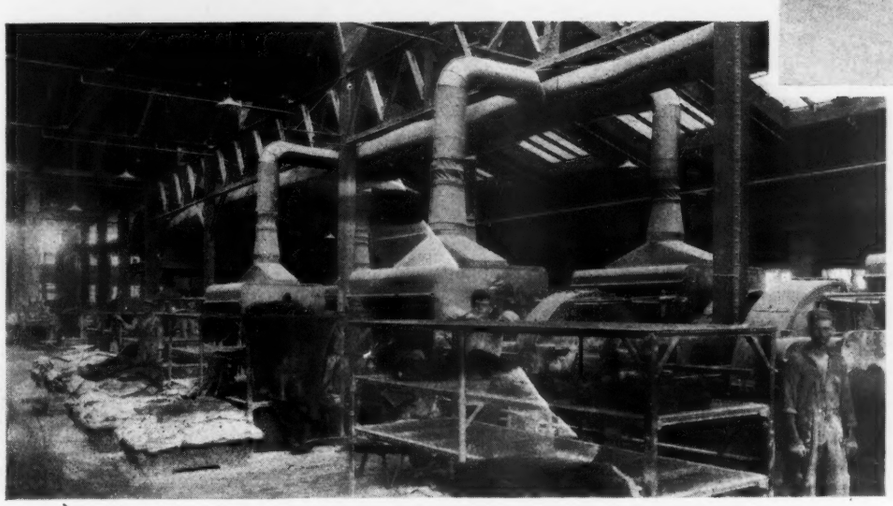
This change made safety a direct function of management and instead of having 18 men spread over 5 main manufacturing divisions, each employing from 1,500 to 5,000 men, as many foremen and inspectors in a division became available. Despite this, little impetus was given to the safety movement until pressure was exerted from above, emphasizing that safety was no longer of secondary importance, but a primary responsibility of every foreman in the plant. To get to the workmen was their problem for as an accident occurred, the investigation resulting placed the blame on the foreman for lacking the ability to recognize the hazard. Personal instruction was found to be the best weapon. If an accident occurs it is rehearsed to find the cause; corrective measures take place, and the men are instructed how to avoid its recurrence, for which there are penalties.

Dirt and disorder, from which few plants are immune, become recognized hazards, and as a result cleanliness became the first order of the day. Without cleanliness there could be no order and likewise no safety. Plant





Open mesh guards tend to obstruct fingers but not vision.



Handrails at floor openings must be as effective as fire doors on elevator shafts.

Dust elimination safeguards workers and machines alike.

SENT HOME AND LOST-TIME ACCIDENT CASES 195 DEPT. Sheet No.

Name	P.R.No.	Case No.	Dept. No.	Bldg. & Floor	Date	Time of Day	Day of Week	Foreman

Statement of Injured
Cause and extent
of injury.

Dept. of Safety and Sanitation
By Date

OFFICE OF SAFETY ENGINEER
SENT HOME ACCIDENT CASES - MONTH Date

Group	Daily Cases	Total Cases to Date	Last Month Same Date
Processing			
Mechanical			
Tire			
Footwear			
Miscellaneous			
Total			

Copy to Mr. T. G. Graham
Mr. T. B. Farrington

This Week's Safety Slogan:

Facsimile of forms on which reports of all accidents are kept up-to-date for official scrutiny.

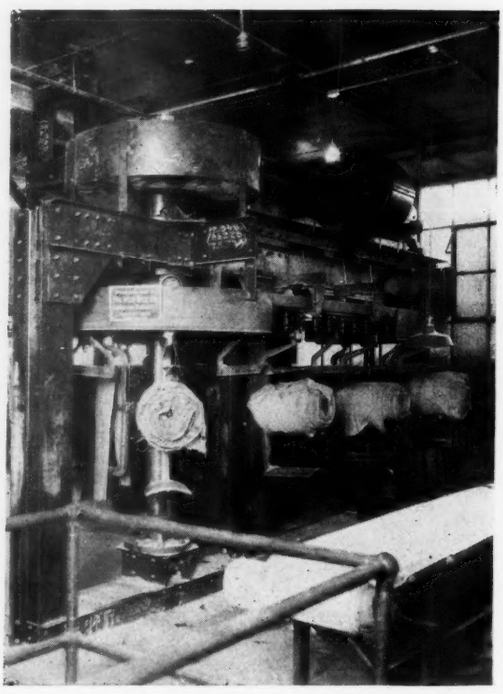
conditions, sanitary and otherwise improved, all of which had a distinct influence on over-all plant efficiency. It was a logical outcome inasmuch as the workers were enabled to concentrate on their work at hand. Competition became keen between departments and divisions for the best safety record. 117 out of 127 departments have a clear record for the month. Several groups averaged approximately 750,000 man-hr. without a lost-time accident. Other groups have worked a year, another group two years, 44 departments two years and seven months without a lost-time accident—one in which the worker loses time beyond the shift in which he was injured. The medical department has sole authority to rule on the eligibility of the worker.

Divisions and departments compete for trophies awarded for safety improvement. One for a period of six months, the others for a year. Posters and display boards kept up-to-date keep the men advised as to the standing of their department. It becomes almost a personal affair when the score of a department is impaired, so keen is the rivalry.

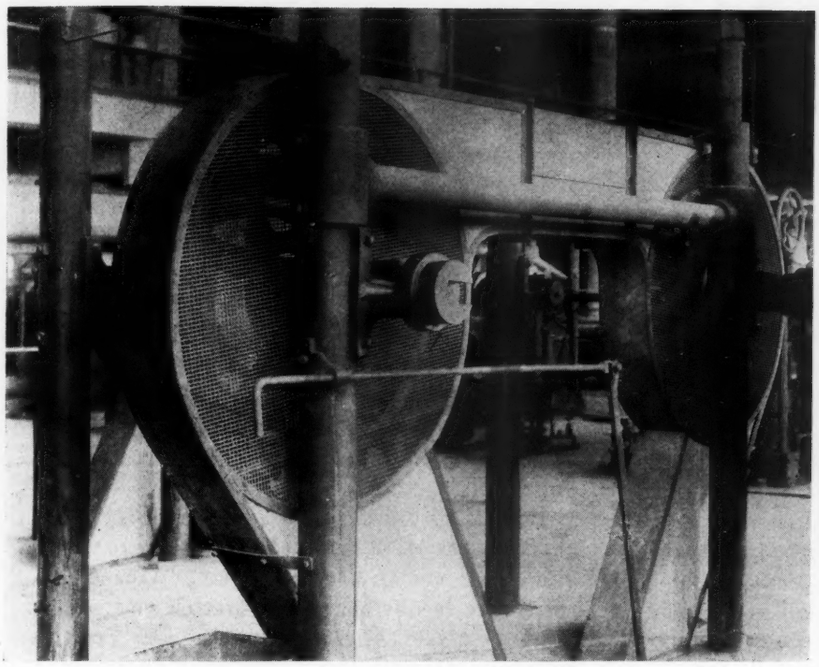
Departmental safety meetings of the general foremen, foremen, and inspectors are scheduled for the year by the safety engineer, who attends most meetings as an interested observer. Permanent chairmen conduct the meetings in which accident reports of the week or the month are reviewed to determine the measures taken to prevent their recurrence. Inspection trips are conducted by appointed groups of foremen from other departments with the general foreman of the department to be inspected to uncover unsafe conditions and practices, and check on orderliness and cleanliness. Known hazards are brought to the attention of workers on similar machines, emphasizing their danger and avoidance. In addition, field engineers from the engineering department, all maintenance men and machinery oilers are self-appointed inspectors who report hazardous conditions.

Preventive hazards receive attention from many sources. Several trained men from the structural-iron and sheet-metal department devote their time to the application of mechanical safeguards. Upon equipment designed or purchased, new building construction or extensions to plant property, the safety engineer is consulted to see if features conform to the best practices in safety and sanitation. If a unit is received with or without guards and approved safety devices it is thoroughly inspected to see what is necessary in the first case and, if it complies with the safety code in the latter case. Very often, production processes are altered in the interests of safety.

Bulk quantities of solvents such as naphtha, gasoline, benzol, etc., are stored underground at a remote location, from which they are pumped to distributing centers in the plant. Automatic control at these points



Inclosed gear guards on overhead drive precludes the possibility of injurious contact. The same applies to foreign matter.



Mechanical safeguards on a chain and sprocket drive between floors.

actuate the pumps at the storage depot, which are closely observed by an attendant when delivering solvents to guard against possible failure to discontinue pumping when the distributing valves are or should be closed.

From these distributing points small quantities of solvents are withdrawn into portable safety dispensers from which smaller quantities are distributed for immediate use, obviating the storing of large quantities within the manufacturing buildings.

Cement manufacture which takes large quantities of solvents is closely guarded as it represents a hazard of the first order. To avoid possible interruptions to this equipment, in continuous service, from fire or other causes, the units are located in separate, sprinklered rooms equipped with fire doors and walls, for which forced ventilation is provided at the ceilings for the light vapors and at the floor levels for the heavier vapors. Motive equipment is of the explosion-proof type with inclosed control equipment mounted outside the rooms. Artificial illumination is provided by means of vapor-proof lamps. At convenient locations are fire extinguishers for emergency use.

Fires are considered on the same basis as accidents. Any blaze, no matter how small, is classed as a fire; even such occurrences as burned out motor windings or overheated bearings are included. Safety rules prohibit welding of any kind, except in welding rooms, unless the fire department is notified and a fireman is in attendance with the necessary protective equipment, thereby assuring the safety of the operators and the prevention of fires. Everybody on the job is trained to prevent or resist a fire in the making. These practices are responsible for keeping the number of fires down to an average of less than one a week, considered low for a plant of this size.

For other departments wherein hazardous conditions exist similar precautions, peculiar to the hazard, are taken. For instance, the condition may be such as to affect the health of the workers. Handling large quantities of lamp black, even though confined to a restricted area, requires an extensive recovery system with its attendant ventilation equipment. The worker is required to wear a mask when weighing and mixing. In the lead casting room forced ventilation is provided in excess of the air required for the furnace to keep lead fumes exhausted to the atmosphere. Heated air from an adjoining manufacturing building during the winter is drawn off through the lead casting room to prevent the lowering of the furnace temperature which would take place if cold air was brought in from the outside. In the sand-blasting division a type of mask is used wherein fresh air is admitted to the mask by means of a hose, permitting the worker to breathe air free from dust or deleterious vapors. Other protective appurtenances such as goggles, gloves, coveralls, and hoods avoid dust penetration.

Without a well-organized medical center comparable to the industry, safety and all it stands for would suffer in direct proportion to the service rendered. If it lacks facilities designed to repair what that industry impaired, it fails in its purpose in that employee confidence and faith are destroyed. To boast of the best is human—it is surpassed by none.

In it employees engaged in operations hazardous to health are regularly examined, and for this work applicants must first pass rigid tests. It controls the employment of workers to the extent that men are alternated, depending on the job, as a means of reducing exposure to a minimum. As a matter of interest, the x-ray film vault was used as a model following the Cleveland Hospital disaster in which over 100 people perished.

To say that a medical center has no place in safety work is a fallacy. It is as much an adjunct to personnel as mechanical safeguards.

Several forms are reproduced, which relate to the reporting of accidents and from which practically all accident statistics are derived. An accident is reported in detail as soon as the investigation is made and the responsibility established, immediately following its occurrence. In reporting accidents the men are unhampered with leading questions usually found on standard forms; they are permitted to explain the accident in their own language.

However, records, too, are but a part of safety. It encompasses efficiency of foreman and workmen, intensifies interest in work and in the company, thereby effecting labor turnover. It provides penalties to back up company policy that it is essential to efficient plant operation.

ACCIDENT STATISTICS

Year	Total Man-Hours	Lost-Time Accidents	Fatalities	Frequency Per Million Hours	Severity Rate per Thousand Hours	Base Rate
1927	29,916,589	1,251	1	41.71	0.52	21.69
1928	30,012,983	921	1	30.68	0.52	15.95
1929	32,424,509	511	0	15.76	0.32	5.04

MAINTENANCE ENGINEERING

L. C. MORROW, *Editor*

Vol. 89 JUNE, 1931 No. 6

Incentive Plans for Maintenance Work

UNDER the present urge to cut costs wherever possible it is not surprising that the application of incentive plans to maintenance work is a very live topic. The results achieved by the application of incentives to production work need no elaboration. Few will deny that there are rich opportunities for cutting the cost of maintenance activities in many plants.

It is equally true that the adaption of incentive plans to maintenance work is beset with enough problems and difficulties to make careful study and open-minded trial essential. Many of the operations performed by the maintenance crew are not of a repetitive character, or one that lends itself readily to the setting up of a standard performance. Many other operations are performed at such infrequent intervals, or the conditions may vary so much each time the work is done, that putting the job on an incentive basis may be impossible, or not worth doing. It is necessary to use much discretion in applying incentive plans, especially for the first time.

Successful application of such plans frequently calls for better planning of work and more careful management of the department as a whole. They are not a panacea to be applied haphazardly and at random. Nevertheless, when worked out and applied in accordance with well-established principles, they offer to both employer and employee money-making opportunities that are too important to be overlooked.

Showers and Thunderstorms

WITH the approach of Summer come those thunderstorms that so often play havoc with electrical equipment—to say nothing of production schedules. In many plants that have few or no overhead distribution lines, the danger from lightning is slight; in other plants, extensive area or other conditions make the possibility of damage by lightning a very real one.

In such plants there are at least two things that should be done promptly: (1) If adequate protective equipment has not been provided, that oversight should be remedied. (2) Lightning protective devices now in service should be thoroughly inspected to make sure that they are in proper condition. Particular attention should be paid to the condition of grounds. Good grounds are absolutely essential for the proper functioning of lightning arresters.

As the result of corrosion or changing soil conditions grounds have the unfortunate habit of losing their effectiveness—the resistance goes up and the protective ability of the arrester goes down. According to one prominent manufacturer, long-continued studies of transformers that have been burned out by lightning indicate that in a large proportion of cases comparatively high resistance of the lightning arrester grounds has been an all-important factor.

It is usually difficult or impossible to judge the effectiveness of a ground by visual inspection—and safer not to try to do so. Measuring the resistance is not a difficult matter and should be done as often as necessary to make certain that it is of sufficiently low value.

Now is a good time to make such measurements.

Maintenance Should Be Budgeted

PROBABLY the devout colored parson did not have maintenance budgets or costs in mind when he announced to his awe-stricken flock that he "knowed the unknowable and was gwine tell the untellable and unscrew the inscrutable." Yet his remarks could be applied with considerable accuracy to the management and accounting methods employed in some plants to keep track of maintenance activities.

In many plants budgets are made covering the important phases of maintenance work and accurate records are kept of all costs, which are properly allocated. In others, and, there is undoubtedly a considerable number of them, cost-keeping methods do not give a clear picture of what is going on, or what it costs.

An example of this nature was found recently in the largest branch of a company that operates several plants. No attempt is made to put maintenance work on a budget and, in the words of the plant engineer, "When the main office thinks I am spending too much money, they make a kick and I have to go easy for a while." The actual requirements for the work evidently count for little in the minds of the powers in the main office. If the expenditures exceed a certain amount, which apparently, has been arbitrarily fixed, they must be curtailed, regardless.

Granting that such an attitude on the part of the management is exceptional, it is obviously

based on an utter lack of understanding of the function and importance of maintenance. Most certainly it is not something that arbitrarily should be curtailed or abandoned on whim or fancy. That way of handling it is not only grossly unfair to the man in charge of maintenance, but is likely to lead to conditions that will be reflected in the yearly balance sheet.

One of the measures that can be taken to insure the needed financial support for maintenance work is the preparation of an annual budget that provides adequately and in detail for all of the activities involved. Every maintenance engineer owes it to his work and to himself to insist that his department be placed on the same operating basis and be given the same attention in the accounting department that the other important departments receive.

When New Machines Are Put in Service

AUTOMOBILES are not the only machines that should be operated slowly and watched carefully, when they are first put into service. Practically all machines that contain rubbing or wearing parts have to undergo a period of running in before they can be operated continuously at maximum speed without injury. Bearings are likely to be tight, gears are stiff—as a rule, all rubbing surfaces, no matter how finely finished, lack the high polish that comes only with actual operation.

With these facts in mind, the practice of having all new machines in one large plant operated by, or directly under the supervision of, the maintenance department for a period of two or three weeks seems to have much in its favor. In many, probably most, plants it is the custom to turn new machines over to the production department as soon as they are installed. From then on it is up to this department to get as much production as possible out of the machines. To the maintenance department falls the oftentimes difficult job of repairing damage caused by neglect or abuse.

In the plant referred to, the period of operation by the maintenance department gives ample time not only for running in bearings, gears, and other parts, but for studying the operation of the machine, making such load tests as may be desirable, testing out the lubrication system, and so on. If any defects show up, they are corrected. When the machine is at last turned over to the shop, the maintenance department knows that it is ready for any service that may properly be required of it.

As a means of securing better service from equipment, and cutting maintenance costs, this plan is worth careful consideration.

Vulcan Fires His Forge Anew

WHEN considering certain periods in the development of mankind, it is convenient to refer to the metals from which men of those periods made their weapons and tools. Hence come the terms Stone Age, Bronze Age, and Iron Age. Our present civilization and industry as we know it today are products of the Iron Age, but historians of the future may indeed consider that the present era marked the passing of that age, and the beginning of what may be termed the Alloy Age.

Until a comparatively few years ago iron was simply iron, with a small amount of incidental impurities; steel was iron with enough combined carbon to permit hardening under appropriate treatment. Brass and bronze, made by the ancients, were the most important of the small number of alloys known. Chromium, vanadium, aluminum, and a host of other metals and elements that find wide use today were either unknown or recognized only as laboratory curiosities.

Within the memory of many who read these pages metallurgy has been put on a sound basis of scientific fact and has made tremendously important contributions to industry. Alloys, relatively cheap in price and with corrosion-resisting properties that were heretofore obtainable only with prohibitively priced noble metals, now are commonplace. Iron, which formerly fell an easy victim to moisture unless thoroughly protected by some covering, now has had its face lifted, so to speak, by the addition of other metals and in the form of stainless steel adds beauty and permanence to some of our mightiest buildings and brightens our automobiles, as well as serving in countless roles that are well known, if less spectacular.

In other cases the paradoxical combination of great strength and invaluable lightness has been incorporated in one metal, or alloy. Extremes of hardness, ductility, machineability, unusual electrical or magnetic properties—practically any desired quality can, within limits, be produced at will. Formerly we made the best we could of the natural properties of the metals available; now, in effect, we make our metals to order. Of course metallurgical research is being carried forward zealously and developments will continue.

What does all this mean to the maintenance engineer? It means that he has been given some remarkable new materials with which to solve many problems that have heretofore been troublesome, if not impossible to solve satisfactorily. He is under the necessity only to keep up with some of the developments of a new science and of being sufficiently open-minded to give new ideas and new materials a fair trial.

LUBRICATING SYSTEMS

(High Pressure)

Sixth article of a series. The seventh will appear in an early issue.

FRED H. LOW
Mechanical Engineer

IN describing high-pressure centralized systems in the preceding article, no mention was made of piped systems or those having lubricant stored in a large reservoir from which it is pumped into pipe lines throughout the plant. Fig. 41 shows a cross-section of an industrial building with a lubrication compressor mounted at the center of the fifth landing and the piping, shown by dotted lines, running throughout the building. The various outlets are indicated by valves.

In a plant of this size, where the number of bearings might run into thousands, lubrication naturally presents a problem, first because of the quantity of lubricant required, and second because of the necessity of supplying the bearings with the proper amount of lubricant at regular intervals.

Essentially, the system consists of a lubrication compressor or reservoir of approximately 400 lb. capacity, a pump with the necessary valves and fittings, and the pipe line for carrying the lubricant throughout the plant. The compressor and pump assembly is shown in Fig. 42. The compressor is air-operated and requires from 40 to 100 lb. per sq. in. pressure.

In operation, air is delivered through a regulator valve, shown at the top of the compressor. This valve keeps the air at any predetermined pressure. By the use of a four-way valve the air is first drawn from the bottom of the tank, under the follower, allowing the follower to drop to the bottom of the compressor. The hand wheel is then opened and the barrel or more of lubricant dumped

Fig. 42—Lubrication compressor and pump assembly. The lubricant supply line is the larger pipe at the left.

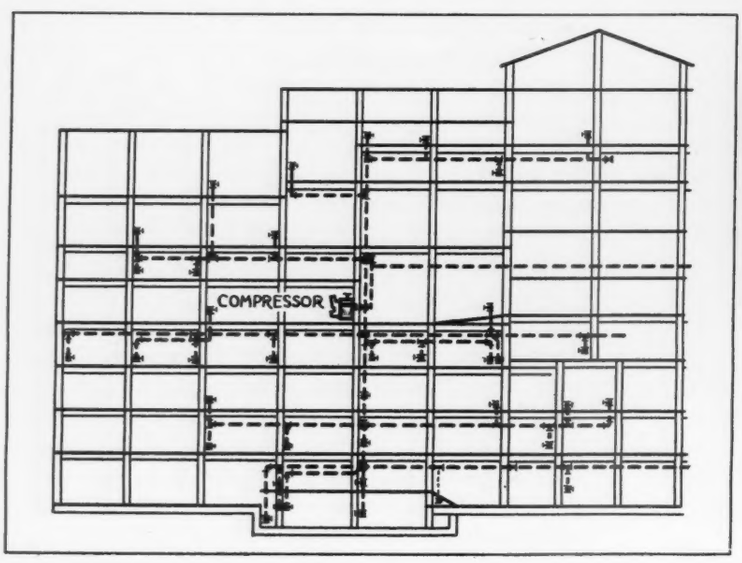


Fig. 41—Profile of a complete central reservoir lubricating system. The lubrication compressor is shown on the fifth floor.

Fig. 45—The control valve and the method of attaching the coupling to the fitting. The control valve is shown at the left.

Fig. 44—Fittings used to attach the flexible hose to the lubricant supply line.

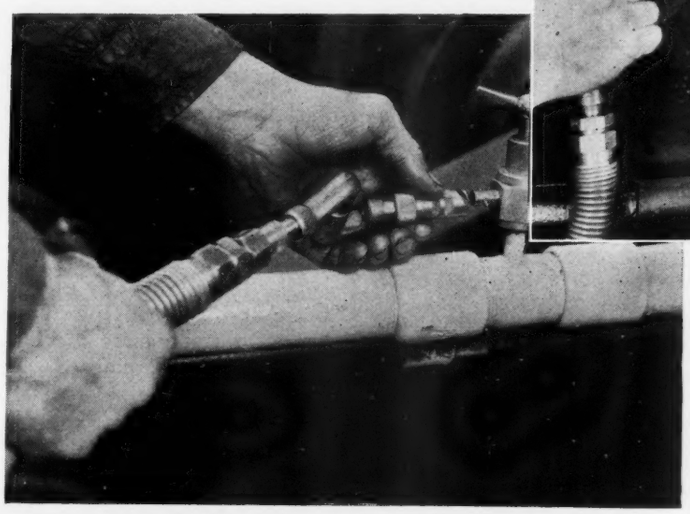


Fig. 43—One of the outlet valves in the main supply line. The operator is using a 20-ft. hose which allows him to lubricate all bearings in a 40-ft. circle.

into the reservoir. The cover is then closed and the valve reversed, permitting the air pressure to accumulate in the bottom of the reservoir, thus raising the follower and forcing the lubricant through a screen and into the pump inlet. The valve to the reciprocating air motor is then opened and, as the bore of the air motor cylinder is 6 in. in diameter and the grease piston approximately 1 in. in diameter, the pressure is raised to 3,600 lb. in the outlet lubricant line.

To convey the lubricant from the compressor to the various shut-off valves located throughout the plant, extra-heavy, 2-in., galvanized pipe ordinarily is used. Galvanized pipe is preferred because it is free from scale. This type of system, because of the air priming feature used in the compressor, is capable of handling lubricants of almost any consistency. Lubricant is transferred once from the original container to the compressor, eliminating storage at various points in the plant.

One of the outlet valves in the lubricant supply line is shown in Fig. 43. Coupled to it is a 20-ft., high-pressure, flexible hose, having swivel connections for ease in handling, and a control valve and coupling to engage the fitting. As may be seen, the operator attaches the coupling to the fitting and squeezes the control valve to permit the lubricant to flow into the bearing.

With the use of this hose, the operator is in a position to lubricate all bearings within a 40-ft. circle of the shut-off valve located in the main pipe line.

When he has finished all the bearings within this circle he closes the shut-off valve, disconnects his hose, and moves on to the next outlet.

Shown in Fig. 44 is a detail of the method of attaching the flexible hose to the shut-off valve in the lubricant pipe line. Operation of the control valve and the method of attaching the coupling to the fitting are illustrated in Fig. 45. The control valve is shown at the left. In Fig. 46, sketches *A, B,* and *C* show details of the lubricant

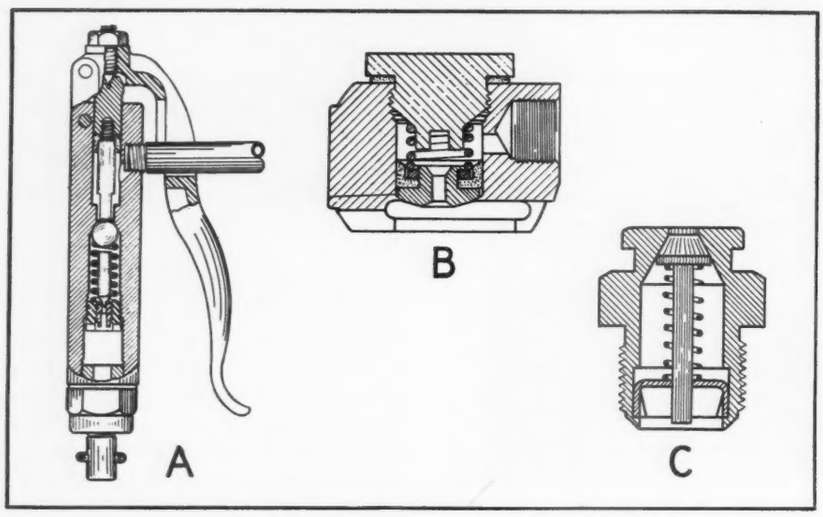


Fig. 55—Drawings A, B, and C show details of the lubricant control valve, coupling, and fitting respectively.

control valve, coupling, and fitting respectively.

Where this type of system is used, as many operators as are necessary can be lubricating in various parts of the plant at the same time without interfering with the lubricant flow—the lubricant pump on the compressor having sufficient capacity to deliver up to 28 lb. of lubricant per min. The pump is automatic in action. As an example, if no lubricant is being taken from the pipe line, the air pressure which operates the air motor balances the pressure in the lubricant line and the motor stops. But, whenever lubricant is drawn from the pipe line, the pressure is unbalanced and the motor will automatically start and again build up the pressure to its former level.

Entire control of the lubricant supply is in the hands of the operator using the control valve.

Systems of this type have been installed with 3,200 linear feet of pipe and embracing over 7,000 ft. of piping in the entire system. In one plant, 13,000 fittings are lubricated regularly by two operators. Each operator can supply as much or as little lubricant as is necessary for the specific bearing and at the same time can make an individual inspection of each bearing.

■ ■

Comment on "Power Factor"

IN his article on page 232 of the May issue, Mr. E. S. Lincoln has covered the subject quite fully. A very rough physical analogy of low power factor which seems to be grasped readily by non-technical persons, is the comparison to a glass filled partly with liquid and partly with foam. It is clear that a certain volume is required to hold the total quantity, although the liquid or useful portion may be only a small part of the total.

It seems to me that anyone who can delve into tangents and cosines, and make use of the curve given in the article, can usually handle a slide rule, or is able to make simple algebraic calculations. It is advantageous to be able to calculate power factor values without reference to trigonometric tables or a ratio curve. This can be done by using the following formula:

Power Factor (in per cent) $= 50\sqrt{(1+A)^3 \div 1 + A^3}$, where A equals $W_2 \div W_1$, W_1 being greater than W_2

All of the operations required can be performed on a slide rule very rapidly, or calculated arithmetically, and the answer is at least as exact as one obtained by reference to tables or curves.

For example, if the power factor is 100 per cent, A is equal to 1. Then,

Power Factor

$$= 50\sqrt{(1+1)^3 \div 1 + 1^3},$$
$$= 50\sqrt{8 \div 2}$$
$$= 50 \times 2 = 100$$

If the power factor is 50 per cent, A equals zero and we have,

Power Factor

$$= 50\sqrt{(1+0)^3 \div 1 + 0^3}$$
$$= 50\sqrt{1 \div 1}$$
$$= 50 \times 1 = 50$$

The formula is very easily remembered and is worthy of consideration from the standpoints of quick, easy, and accurate handling of such problems.

C. O. VON DANNENBERG.
New York, N. Y.

■

Our Mistake

ON the book page last month we described a pamphlet of Standards for panelboards and distribution boards issued by the National Electrical Manufacturers Association, and called it "NELA Standards for Panelboards." This, of course, should have been "NEMA Standards for Panelboards."

■

Westinghouse Develops "De-Ion" Lightning Protector

A GIANT "spark plug" in the Westinghouse high-power laboratory blazed into action and over 132,000,000 volt-amperes leaped across the terminals to a lightning rod on test.

There was a burst of flame from each end of the rod and the report of a 6-in. cannon as the experimental lightning-rod "knocked out" the lightning in less than 1/500 of a second.

This device, known as the "De-Ion" lightning protector, is used to protect insulator strings on tranmission lines against flashover. Its construction is simple. It consists of a hollow tube about the size of a lady's umbrella. A piece of metal at each end serves as an electrode to entice the lightning inside for the "knock out" blow. It is supposed to work so fast that the lights in a house will not even flicker.

AROUND the WORKS

A section devoted to short articles describing practical methods devised to meet specific operating conditions. The items may refer to details of installation, inspection and testing for maintenance, wiring, repair, and replacement.

Controlled Heat Improves Glue-Pot Operation

AN interesting problem of temperature control was encountered in the woodworking department of the plant with which I am connected. A number of electric glue pots are in use, the glue for which is prepared in a steam boiler and transferred to the individual pots where it is kept hot for the production operations.

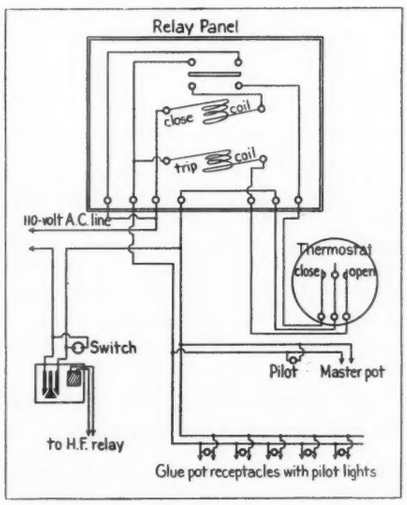
Some difficulty with the finished work disclosed the fact that the glueing operations were not satisfactory. The firm supplying the glue maintained that the correct working temperature should be 155 deg. F., however, a heat test of the various pots showed that the temperature varied from 120 to 135 deg. F. This condition was blamed for the defective work so the problem was turned over to the electrical department for solution.

These pots are of the 2-qt. size. The heating element, rated at 85 watts, consists of nicrome wire wound on flat mica strips inserted between mica disks and inclosed with steel plates. It was suggested that to remove a few turns of the heating element would be an inexpensive way out of the difficulty, which scheme was tried experimentally on one pot. By this means the temperature was raised to 145 deg. F., but an additional strain was placed on the heating element. This scheme was not considered a satisfactory solution.

Two heating units were then installed in one pot and connected in parallel, there being enough room to insert them between the steel plates. This arrangement gave a maximum temperature of 212 deg. F., which was too high. It was obvious that some method of temperature control would be required that would be independent of the operators.

There was available a second-hand, temperature-control instrument of the electric-contact type with relay, which had been salvaged from an electric oven. It was decided to utilize this equipment for controlling the temperature. The method used was as follows: As all the glue pots were on one circuit, it was possible to cut the thermostat in on the supply lines and control all from one point. One glue pot was installed beside the control instrument to serve as a master pot. The element of the control was coiled in the bottom of this pot. Water was used in the master pot instead of the glue.

A small needle valve and a float from a discarded vacuum tank were fitted to the pot to provide make-up water, but excessive pressure necessitated the installation of a supply tank above the master pot. This arrangement worked very satisfactorily as the small amount of feed water entering the pot was insufficient to cause any serious temperature difference in the master pot.



Connection diagram of devices used to maintain specified temperature of glue pots automatically.

High-frequency electric tools are used in this plan and the frequency booster set is in operation only when the department is working. This fact enabled us to add another feature to the control to make it entirely automatic.

A small contactor was cut into the supply circuit of the glue pots, its actuating magnet in parallel with the field contactor of the frequency changer. When the machine is started in the morning the glue-pot circuit is switched on, and when the machine is shut down at night the circuit is automatically disconnected. A hand-operated switch is provided so that the circuit can be closed, if necessary, when the machine is at rest.

It was found that if the water in the master pot was maintained at a temperature of 140 deg. F., the glue pots maintained a temperature of from 155 to 160 deg. F., which is in accordance with the requirements. A recording thermometer on the installation showed excellent regulation.

Toronto, Canada — ELLIS MILLS.

■

Care of Air Suction Lines on Gas Compressors

AIR suction lines on gas compressors should be protected against corrosion, especially if the air is damp or near the sea.

In a case in which suction lines of steel pipe were used, the damp air caused the formation of rust on the inside of the pipes, which was drawn into the compressor valves.

Painting the inside of the pipes with lacquer proved only a temporary remedy because the paint soon came off in scales.

Galvanizing the pipe was found to be the best method, in spite of its expense, to eliminate these troubles.

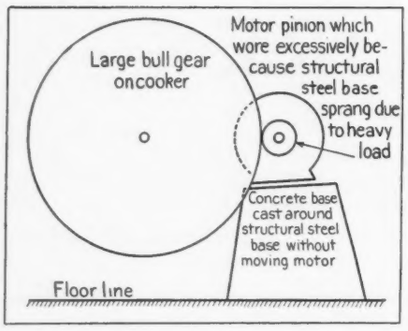
Where, in the case of large compressors, the air is brought in through a concrete duct, the duct must be of such size that a man can get into it to finish the concrete and paint it with a damp-resisting enamel.

Arcadia, Calif. — M. C. COCKSHOTT.

■

Gear Teeth Wear Minimized by Stiffening Motor Mounting

IN a western packing plant a rotating cooker was driven through a pinion on an electric motor and a large gear attached to the cooker. Because equipment usually is hosed daily with hot water in the packing industry it is general practice to mount motors above the floor to protect them from the water. Consequently in the original cooker


Large bull gear on cooker
Motor pinion which wore excessively because structural steel base sprang due to heavy load
Concrete base cast around structural steel base without moving motor
Floor line

Casting a concrete base around the existing structural steel mounting, eliminated excessive tooth wear in the pinion of this cooker drive.

drive the motor was mounted on a structural-steel framework, at a height which brought the center of the pinion level with the center of the gear—about 30 in. from the floor.

Tooth pressure on the pinion proved sufficient to spring the structural-steel mounting, causing misalignment and motion. Results were excessive wear and occasional breakage of gear teeth.

After attempts to strengthen the steel framework proved to be unsuccessful, the problem was simply and economically solved by installing a concrete base. The concrete was poured and cast around the original steel framework. This method of installation had the advantage of not only eliminating the necessity of removing the original steel base and remounting the motor but the old framework served the purpose of reinforcing steel.

The concrete base now holds the motor and pinion rigidly in alignment, and the gear teeth have shown no noticeable wear since its installation.

Chicago, Ill. F. E. GOODING.

■

Temporary Bearing Repairs

RESOURCEFUL plant engineers will not permit such a trifling item as a burned out bearing to stop operations when interruption means a loss of production. If the bearing can be made to hold for a short while there may be ample time to effect a repair without closing down the assembly line.

With ball and roller bearings we often lose sight of the bearing characteristics of other elements. Perhaps some readers will recall a time when they were out on a highway with a burned out connecting-rod bearing. It has been my experience, yet I did not have the car towed to a garage. I cut a piece of leather large enough to lay in the rod, put on lubricating oil and pulled the bolts tight.

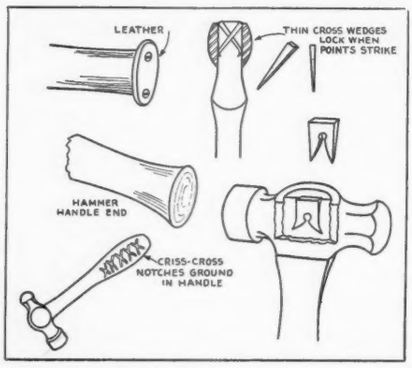
Since that time I have used this means of temporary repair and found that it can be relied upon to keep a machine on the line until an opportune time presented itself for permanent repair. It is obvious that this type of repair cannot be used where the bearing load is beyond the capacity of leather or where the speed is exceptionally high.

Waterloo, Iowa H. C. CHARLES.

■

Keep the Head on the Hammer

I AM not surprised that the lowly hammer, as reported in your January editorial, was found to be the cause of so many permanent injuries.



The safety committee of any plant would do well to post some of the sketches shown herewith on the bulletin board that mechanics might make their hammers keep their heads.

Concord, N. H. C. H. WILLEY.

■

Trap Door Provides Access to Scale Mechanism

PLANT engineers will find the suggestion illustrated in the accompanying photograph practical. We had the occasion to install a number of platform scales in one of our warehouses and after they had been in operation about a year it was decided to inspect the knife edges and test the scales for accuracy. When we endeavored to get into the scale pit we found that no means had been provided without taking up the entire platform. As a result the trap door was provided as shown.

This trap door is equipped with recessed handles and is reinforced with angle iron to insure strength and uniformity of floor surface. It is large enough to permit a man to enter, taking with him such tools as are necessary to make adjustment of the beams and knife edges located below. I have found that it pays to build a large pit under each scale, so that a man may enter and have room enough to work without removing the entire platform from the floor. This feature not only saves money in repairs, but assures that scales will be kept in better operating condition.

K. D. HAMILTON.

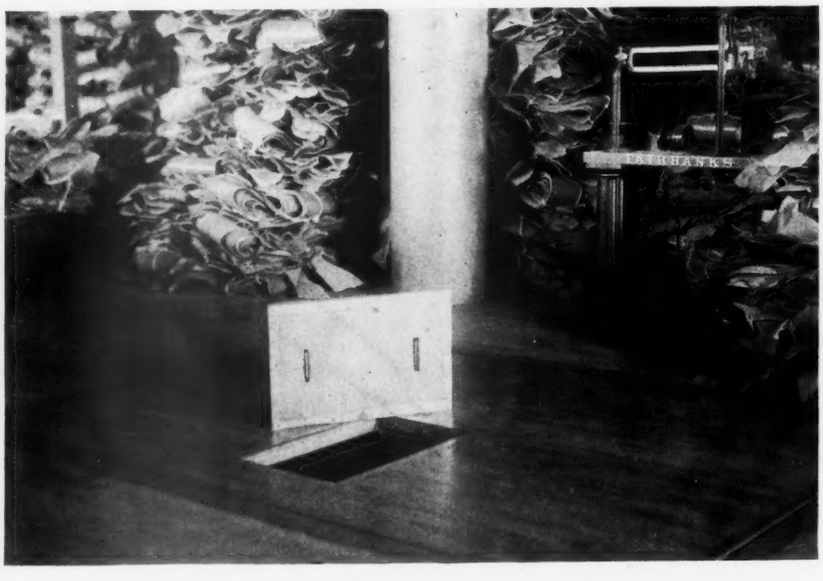
Mechanical Department
Geo. E. Keith Company
Campello, Brockton, Mass.

■

How to Erase Lines from Vellum Paper

THE article appearing under the above title in the May issue of MAINTENANCE ENGINEERING advocates the use of castor oil for decreasing the prominence of creased lines and spots caused by erasures on vellum tracings so that they will not show up on the blueprint. The method is a good one and undoubtedly will be of value in cases in which the vellum already has become creased and spotted.

But with this material, as with many other things, an ounce of prevention is worth the well-known pound of cure; it is much better to keep such tracings between pieces of three-ply panel or wallboard and, when they must be han-



dled, handle them carefully. Such a system is very easy to follow and is well worth the small amount of care entailed by its operation.

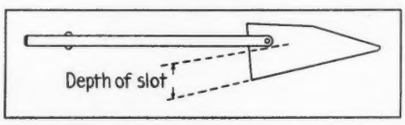
In regard to erasures on vellum paper, here again there are precautions which may be taken. Simply obtain a cake of magnesia, which can be purchased at practically any pharmacy, tear the paper away along one edge or end, and rub the magnesia over the surface of the paper upon which the drawing is to be made. Once the drawing is so covered, it will be possible to erase easily any penciled line so that it will not appear on the blueprint.

Peoria, Ill. JOHN F. HYLER.

■

Stripping Tight Windings

IN former days stripping was usually given but trivial consideration as far as labor costs were concerned. Cost of new equipment was such that the maintenance man, in most cases, enjoyed a large margin of economy in favor of rewinding compared with complete replacement, and about the only important problem was that of producing a rewind that would above all things, give maximum service. Stripping, being but a small part of the total labor involved was, therefore, an unimportant detail.



Wedge with 30-deg. taper for driving coils out of slots.

With advanced manufacturing efficiency and specialization, low cost and improved design of new equipment changes the former situation and the maintenance man, when considering a rewind, faces a problem in economy wherein the cost factors are entirely changed.

In a shop where no great quantity of winding is being done the actual cost of rewinding small, general-purpose motors will likely be greater than the cost of a new stator or armature and often even greater than an entirely new motor. Nevertheless the winding must be done, and usually in a rush when no spares are available.

Time cannot be lost stripping, and to make matters worse many small motors to be rewound are found so well impregnated and baked that to remove the winding as found, involves so much labor as to be prohibitive.

It has been observed that cores previously burned develop a tendency to rust between laminations after return to service, though no apparent damage was revealed by examination or test soon after the burning.

When burning must be done, it has been found best by experiment to use current sufficient to heat the coils rapidly. In this way the highest temperature is attained at the center of the coils imbedded in the slots, while the external method heats the core surface to a higher temperature than is conducted into the coils in the slots.

I have never found it necessary to burn an open-slot stator or armature; nor to separately remove the retaining fibers unless they are unusually thick and strong, as in large machines. In such cases they usually drive out easily and can be used again. An electric or pneumatic hammer equipped with a steel driving wedge of correct dimensions will remove the most stubborn open-slot coils with ease.

In deep-slot, two-layer windings the wedge is started at the bottom of the slot and both coils are forced out together. The fiber-retaining wedge is forced upward out of the groove and seldom presents appreciable resistance. Though this method is severe and positive there has been no trouble experienced in the way of damaged cores. It has been found important, however, that the steel wedge properly fits the slot. Disconnecting the winding is also unnecessary for, by working from the side opposite the connection, the coils can be pushed forward out of the way as they are removed.

When coils are to be saved, best results have been obtained by using a fiber wedge and a lighter, faster hammer. Coils that are dry and hard, and on which the insulation tends to crack have often been saved by heating with current until the insulation becomes pliable.

San Francisco, Calif. W. O. HURLBUT.

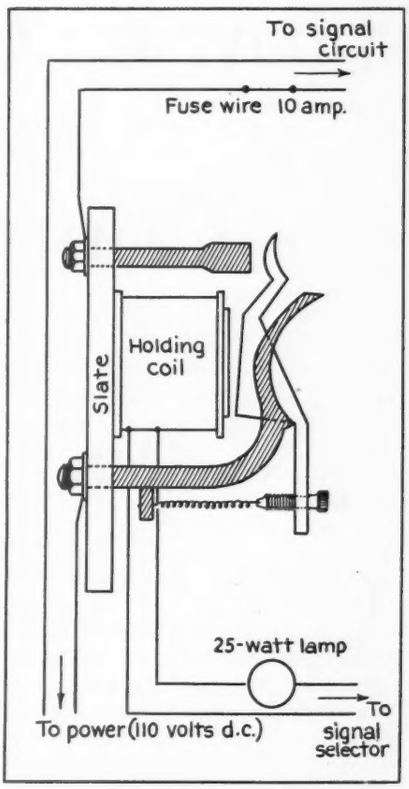
■

Auto-Starter Contractors

ANYONE knowing the important part a signal system plays in manufacturing plants and many other places will not fail to realize the time wasted in locating department heads and other executives in an emergency when this device is out of order.

When the contacting solenoid of the relay of a signal system, operating 50 bells and a flash signal, became shorted and burned out and there were no spares to replace it, a single contactor auto-starter proved a good stand-by after a few simple alterations had been made.

The original signal relay had two contactors; one in each leg of the secondary circuit, and since the auto-starter had only one, one leg of this circuit had to be jumped. Fuse wire was used for the purpose. The other leg was connected in series with the contacts of the auto-starter, after which the two leads of the holding coil were disconnected from the slate base and connected in series with a lamp to limit the current to a safe value, then to the primary circuit of the call selecting apparatus.



A 240-volt, 1-hp., d.c., single-contactor, auto-starter used in an emergency for a signal-system relay.

This substitute was put in working order in an hour's time and worked satisfactorily for the two and a half days that were required in ordering and installing the new solenoid.

A. A. A. RODRIQUES.

New York, N. Y.

■

Metallic Sheath Prolongs Life of Portable Tool Cord

PLANTS employing quantities of portable tools such as electric drills, hammers, and so on can profit by our experience in solving cord troubles. These tools have a way of being troublesome and, for the most part, in the cord when it enters the body of the tool.

Continual bending of the cord causes the wires to break, developing short circuits, or at least a worn cord.

We tried different ways of preventing this trouble; by placing hose around the cord, and by using a cord with a heavy outer insulation. Despite these precautions the trouble persisted until we equipped each cord with a sheath of BX flexible covering, attaching it to the holder. A piece about a foot in length, through which the cord is pulled, is sufficient for the purpose.

Chief Electrician J. W. HEPNER.
Standard Tool Company
Cleveland, Ohio

How to Get the Most Out of Control In Steel Mills

P. B. HARWOOD
Electrical Engineer, Cutler-Hammer, Inc.
Milwaukee, Wis.

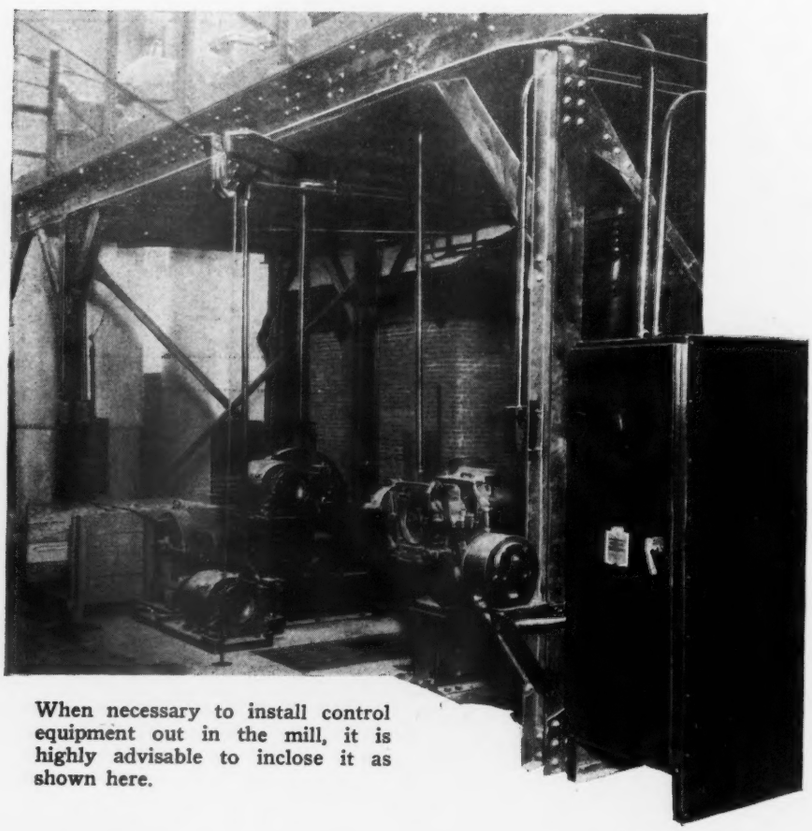
CONTROL equipment, like other apparatus, is built and purchased to perform certain functions. Whether it performs these functions satisfactorily and if so, whether the user obtains the full measure of service that the equipment is capable of rendering, depends on several factors. In the case of control equipment in steel mills the problem of securing maximum service may be reduced to the following elements:

1. Select control designed to meet the conditions of the installation.
2. Apply the proper motor and control for the drive.
3. Install the equipment properly.
4. Maintain it adequately.

Although these principles are simple, it is evident that to apply them a good deal of study is necessary.

The conditions under which control must operate in a steel mill are different from those met in any other industry; it is, therefore, logical that a special type of control has been developed for such service. The loads handled are extremely variable, ranging all the way from very light to very heavy, and from infrequent operation to extremely rapid cycles. Some machines may not be used for a considerable time, and so are stiff and hard to move. After they have run for a while they loosen up and the load drops off considerably. It is essential that the machines respond in as nearly the same manner as possible, under these varying conditions.

In general, the machinery is operated by men who are not familiar with motors and controllers; so there is always the possibility of abuse. In fact, it is essential to design the control so that it may be operated by an inexperienced person.



When necessary to install control equipment out in the mill, it is highly advisable to inclose it as shown here.

Again, there are various kinds of dust and scale to consider. Some of the dust encountered in the mill is a conductor, and is likely to cause short circuits and grounds on control panels. Other dust is non-conducting, but is likely to cause failure of interlocking fingers on contactors, and faulty operation of small relays and light contacts. Oxidizing gases are also to be considered in some cases; where these are present it is necessary to protect copper parts either by plating or inclosing them.

With these conditions in mind, let us consider the requirements of a controller. The outstanding requirement of a steel mill controller is reliability. When the tremendous investment cost of a mill is considered, insurance against shut-downs is of vital importance; consequently, every link in the chain of processes must be reliable.

Probably the second most important requirement is long life. Great improvements in this respect have been made in the past few years. Long life and reliability go hand in hand. In addition, the longer the life of

equipment, the lower the maintenance cost. In the past few years steel mill magnetic contactors, for example, have been so greatly improved that the life of the arcing contacts has been increased from two to ten times over what it was a few years ago. This increased life has resulted from improvements in blowout magnet structures and other changes in design. Greatly improved arc shields have been developed, and their life has been increased from a few thousand to many millions of operations. Improvements have also been made in the bearings of magnetic contactors, so that bearing wear has been greatly reduced.

The third requirement of a good steel mill controller is simplicity. There should be only a small number of wearing parts, and these parts should be easily accessible. A minimum amount of adjustment should be required, and easily be made. There should also be a minimum number of different parts. That is, for various types of contactors of a given rating, wearing parts such as contact tips, arc shields, interlock fingers, etc., should be interchangeable over the whole line of contactors. Simplicity makes maintenance easier and reduces the cost of the spare parts stock. It also means that there are less parts to get out of adjustment and give trouble.

The time-limit controllers that have come into wide use have the great advantage of extreme simplicity, as compared to the old current-limit controllers. Multi-speed, current-limit controllers required a small series relay having light contacts with each accelerating contactor, and auxiliary interlocking fingers on each accelerating contactor.

Single-speed controllers had neither the relays nor the interlocks, but used accelerating contactors having series-wound coils. As these coils carried motor current, different coils were required for each size of motor. With the up-to-date type of time-limit control, both relays and interlocks are eliminated, and shunt coils are used. One of these panels may be used, without change, to control any size of motor within the rating of the contactors.

Time-limit control has also made it possible to meet another vital requirement of steel mill service—the motor must respond at the same rate every time it is operated, regardless of the load conditions. The various drives in a mill are part of a chain of operations, and in order to synchronize the operation of the drives, it is necessary that the motors always respond in the same time. Operators soon become accustomed to the rate of response of a given machine, and if the rate is always the same, can time themselves very accurately and synchronize their movements to get maximum production.

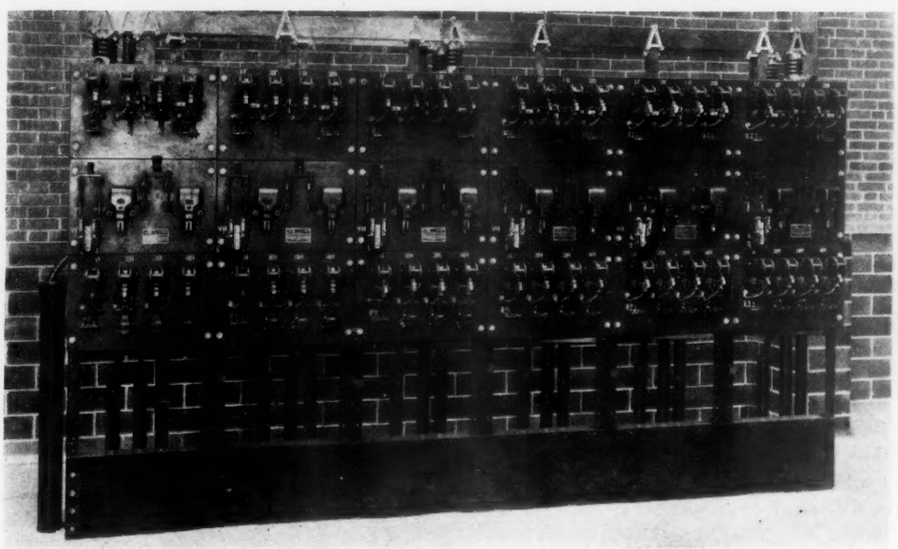
Rate of response also becomes a vital necessity when various machines are started up automatically. When a piece in process reaches a certain point and trips a limit switch, it causes the next drive to operate. In order to get the maximum speed of the whole chain, the drives must always respond at the same rate.

The second factor is proper application of the control. This is a broad subject, requiring not only consideration of the controller itself, but also of the power available, the proper motor, the characteristics of the driven machine, and the part that the operator plays.

Much has been written concerning the use of alternating or direct current for various drives, and the application of the proper motor. There is not space here for a discussion of this part of the problem. Full information on the characteristics of the machine and its functions should be available to the control manufacturer. He should also be given a clear understanding of the part the operator plays. It is, of course, possible to install manual control, with which the operator has the responsibility for doing the right thing at the right time. It is also possible to install entirely automatic control, with which the operator has only to push a button or move a control lever.

In between these two extremes there are all sorts of combinations, one of which will likely be the best for a given installation. There are many advantages in favor of the completely automatic equipments; obviously the motor and machine are not liable to abuse by an ignorant operator, and the cycle of operation is always the same. However, the higher cost of completely automatic equipment is a factor that must be considered. Very often, if complete information is given to the control manufacturer, with a statement of the operator's functions, the control engineers will be able to make suggestions that may result in better operation, greater safety, and higher efficiency of the drive.

Most steel mill electrical superintendents realize that proper installation has great advantages. It was formerly the practice to install the control board near the motor and machines, which generally meant out in the open mill where it was subject to dust and dirt, and mechanical injury. Controllers so installed were also available for adjustment by anyone who thought they needed it.



An up-to-date control board for several important pieces of auxiliary equipment in a new mill. Installed in a room apart from the mill, the control is protected from dust and mechanical injury.

The present tendency is to install controllers in separate rooms designed for that purpose. In many cases these rooms are ventilated by washed air, to keep out dirt or dust, and are accessible only to authorized persons. In such rooms the control is less of a safety hazard, as the operators never come in contact with it.

It was formerly standard practice to mount each contactor and relay on a separate small slate, and assemble these slates on a framework of pipe and angle iron. If a contactor or relay gave trouble it was possible to remove it and substitute another in its place. With the greatly increased life of contactors today, unit construction no longer possesses such an advantage.

Consequently, control boards now follow switchboard design.

When it is necessary to mount equipment out in the mill, present-day practice tends to complete inclosure of the control panel. In some cases a simple, sheet-metal cabinet is sufficient. Where there is a great deal of dust or gas fumes, inclosing cases of heavier material having welded joints are used. These cases have a packing around the joints of the door and are dust-tight and practically water-tight.

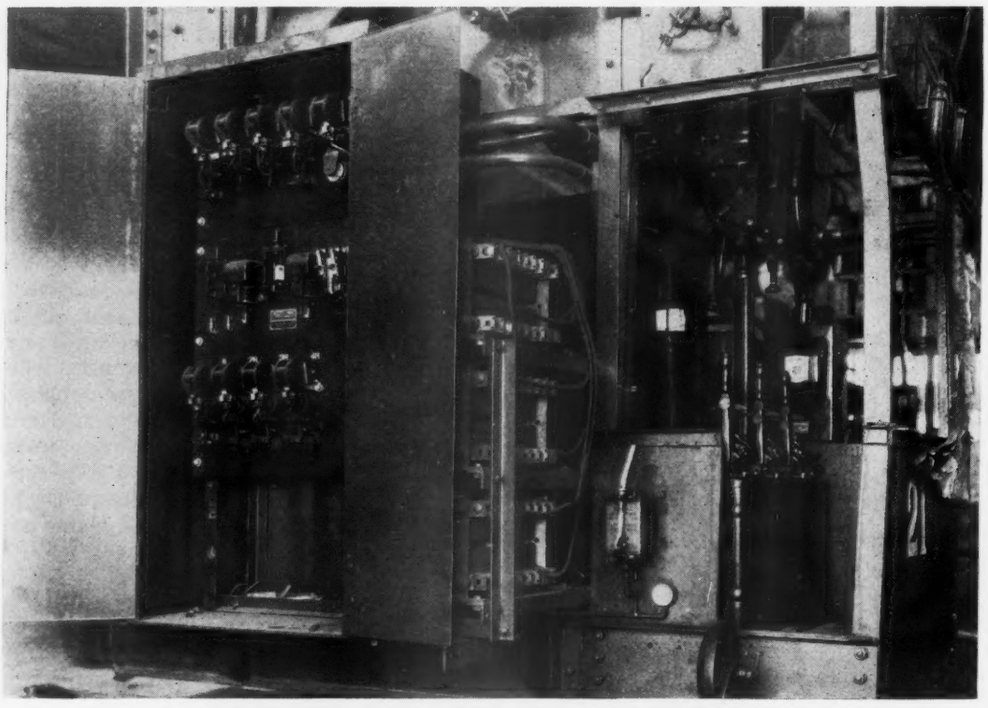
Good maintenance includes, of course, adequate inspection by competent men at regular intervals. Most steel mills realize this fact and make every effort to maintain their controllers properly. It is also necessary to have an adequate stock of spare parts available. These parts should include arcing contacts, blowout arc shields, coils, springs, and any parts that are subject to wear.

Spare parts should be purchased from the manufacturer of the control. This is an important point. It is, of course, possible to purchase bootleg parts, which are generally manufactured by some small concern. However, the man who is copying the part has no picture of the conditions which it must meet, or of the tolerances allowable.

As an example, certain contactors use a magnetic core made of a special steel. This core looks like any other steel core, but a copy made from ordinary steel would not give anything like the proper operation of the contactor. Certain steel parts may be specially heat-treated, but such treatment is not evident on inspection.

The very greatly increased life of arc shields as the result of years of experimental work has been mentioned before. Similar shields of some other material will not only fail to give anywhere near the same life, but they will greatly reduce the life of the arcing contacts. It is extremely poor economy to purchase parts that will wear out in a fraction of the life of the genuine part, even though the latter has a higher first cost.

In recent years there has been a noticeable change in the attitude of steel millmen toward control equipment and an increasing appreciation of its importance. Getting the most out of control equipment is a very important step toward getting the most out of motors, machinery, and men.



Inclosing the control equipment on traveling cranes in steel mills is a sensible and logical procedure that will result in better service and lower maintenance costs.

QUESTIONS *and* ANSWERS

Painting Concrete Floors to Prevent Dusting

To overcome "dusting" of the concrete floors in some of our washrooms and offices I want to paint them, and shall appreciate it if readers will answer the following questions: (1) Will paint adhere well to such floors? (2) If applied directly, will it harden the concrete sufficiently to prevent further dusting and enable it to stand reasonable traffic, or will it be advisable to apply one of the commercial floor hardeners first? (3) Is any preparation other than cleaning necessary if paint is applied directly without a hardener? (4) Can ordinary floor paint be used?

Richmond, Va. **S. V. B.**

■

Covering Water Line to Prevent Sweating

We are having a great deal of trouble from condensation on a cold water line. The pipe has been covered twice, within two years, with an anti-sweat pipe covering of wool felt, but the covering is beginning to rot again, and will soon have to be replaced. The temperature of the room is about 75 deg. F.; the pipe carries city water and is quite cool. I should like to know if someone can recommend an effective method of eliminating this trouble.

Newark, N. J. **G. W. L.**

■

Trouble with Field Coil of Elevator Motor

Will someone please give me help on the following question? One of our elevators is operated by an Imperial Electric 15-hp., 220-volt, 850-r.p.m., d.c. motor. It is a four-pole, compound-wound, interpole machine, with Cutler-Hammer control. One of the field coils is giving us a great deal of trouble by burning out or becoming grounded within a week to a month after installation. The other field coils do not give us any trouble. I have checked up all of the connections and apparently they are correct. How can I determine what causes this one field coil to burn out or ground?

New York, N. Y. **J. B. S.**

Please submit answers promptly. We expect to publish no answers later than the second issue following the appearance of the question. Selection will be made on the basis of quality, but answers first received have the best chance of being used.

Should Building Temperature Be Allowed to Drop at Night?

Our plant consists of two main buildings, 300x200 ft., three stories high, with large window areas. About half of the original pipe coil radiation has been replaced with unit heaters. We have a low-pressure steam plant for heating only. Can readers tell me definitely: (1) From the standpoint of heating costs, is it advisable to maintain the daytime temperature constantly, or should it be allowed to drop during the night? (2) If it is advisable to let it drop, what is the minimum economical temperature? (3) What factors will determine the minimum economical temperature?

Boston, Mass. **A. I. M.**

FROM the standpoint of heating cost alone the temperature should be allowed to drop at night, because the closer the temperature inside approaches that outside, the smaller is the heat loss per square foot of wall, ceiling, and glass area. Several factors help to determine the minimum temperature to which a building may economically be allowed to drop.

Theoretically, the temperature should be allowed to drop to what it will during the night, but practically, this is not always economical or feasible. (1) There may be water systems that will freeze if the temperature drops low enough. (2) Possibly the boiler plant is not large enough to pick up the load in a short time, which might require keeping a fireman on duty for more hours, whereas a watchman might handle a light fire during the night. (3) The radiating capacity may be such that the building can be brought to normal temperature within two hours, say, at 0 deg. F. outside, whereas if the external temperature were —20 deg. F. the radiation might be too small to bring the building up to normal temperature within a reasonable length of time.

In general, the optimum temperature to carry during the night will be governed by: the external temperature; amount of radiation installed and its overload capacity; size of boiler plant and its overload capacity; number of hours fireman or boiler tender is required in each case; materials or equipment, such as water lines, that may be damaged by freezing.

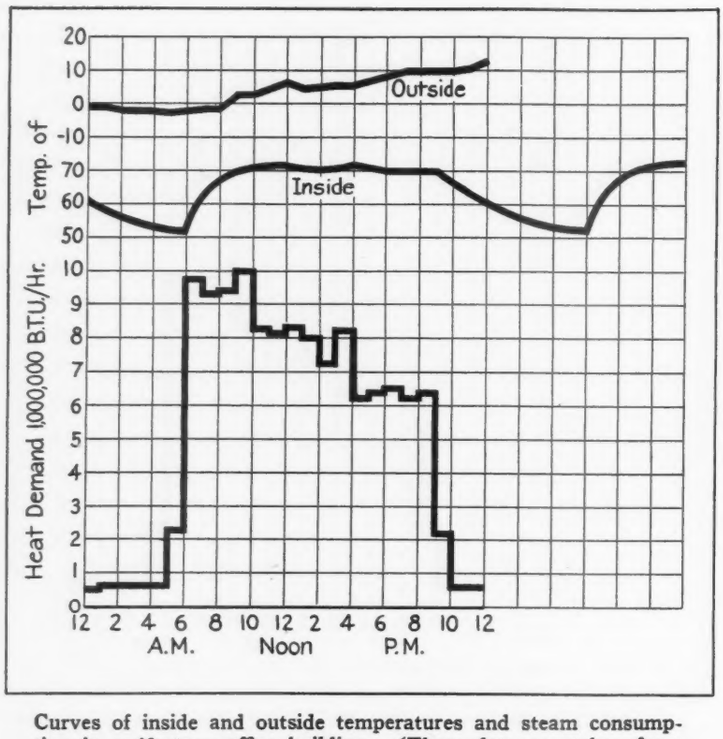
From the above it is evident that the economical minimum temperature may vary in the same plant from night to night, owing to differences in external temperature and wind velocity.

Chanute, Kan. H. R. WILLIAMS.

AFTER considerable study and testing, I have come to the conclusion that there is no general answer to the question of night temperature control in buildings. Strictly from the standpoint of heat requirements, reliable test data that exclude the theories and personal opinions that unfortunately enter into this question, show that it is best to shut off the steam at night.

Supporting this view is the accompanying curve showing data from a 40-story office building. Steam is purchased, and the data are as reliable as meters can make them. Notice that with the temperature of the outside air below zero, and the steam completely shut off until about 6 o'clock in the morning, the morning peak is not what I would call noticeable. Shutting off steam at night is the easiest way of saving heat, in spite of the widely held view that it costs more to heat up a building in the morning than to keep it warm all night. The heat that must be supplied in the morning is equal to the heat lost during the night. As the building cools off during the night, the heat lost must be less than it would have been with the steam on, because the loss decreases as the temperature difference between the inside and outside decreases.

Heating requirements for a building depend on many factors, including the



Curves of inside and outside temperatures and steam consumption in a 40-story office building. (These data are taken from the Proceedings of the National District Heating Association.)

temperature difference, wall construction and glass area, contents, air infiltration, and wind velocity. After the steam is shut off the only heat available to maintain the temperature is that given off by the walls and room contents. Massive concrete buildings will cool slowly; light structures and those with large glass areas will cool more rapidly. In general, the more rapidly a building cools the more rapidly it can be heated up. Consequently, the more that can be saved by shutting off the heat at night except, and this is usually the deciding point, it is generally desirable to maintain a definite minimum temperature because of the contents. In this case intermittent operation is sometimes desirable; that is, leaving the heat on in one section at a time, and rotating the sections.

With proper operation, the heat load peaks in the morning should not be excessive, assuming good building construction and direct radiation. Unit heaters must be watched more carefully. A cold radiator will pull a considerable load, but the convection currents in the room are not sufficient to maintain this peak after the radiator itself is hot. With unit heaters the peak lasts until the room is practically heated up. If all of the unit heaters in a plant are turned on at once, they will pull the boiler inside out, unless it has ample capacity.

If heating the plant can be handled in stages, bringing the temperature up first in one section and then in another, a good, even, morning load extending over an hour and a half, or two hours, can be obtained without excessive peaks.

My recommendation is, first find out the minimum temperature allowed by the contents of the room and if there is no limit, shut the heat off, before quitting time.

Brooklyn, N. Y. P. F. ROGERS.

DROPPING the night temperature in a building or plant to about 40 deg. F., if conditions will permit, will result in sizable savings. In determining the permissible drop, I have found the following factors to be very important. The warming-up period involves other than the estimated losses, some of which are difficult, if not impossible, to predetermine. However, these factors will give a starting point from which A.I.M. may work in checking up his plant:

1. Sufficient and properly allocated radiation.
2. Ample, flexible, and economical boiler capacity.
3. Ratio of normal boiler load to designed load.
4. Liberally proportioned supply piping.
5. Proper drainage equipment for quick starting.
6. Proper provision for rapid elimination of air from system.
7. Lowest temperature safety of plumbing will permit.
8. Chemical action of process solutions when cold.
9. Effect of congealing of lubricants in machinery, when cold.
10. Time permitted for warming up.
11. Occupancy, whether sedentary or active during day.
12. Type of building construction, and its specific heat.
13. Contents of building, and their specific heat.
14. Possible heat gains during warming-up period.
15. Infiltration and loss of air during night.
16. Heat absorbed by process solutions during warming-up period.

The above list is not exhaustive, by any means, but is given to show how variable the warming-up load—the chief concern—may be.

I advise that an operating graph be made for the use of the operator, which will tell when and how much steam is to be turned on, according to the varying weather conditions. An inexpensive recording thermometer for outside temperatures, when used with the graph will save its cost many times over during one heating season.

WILLIAM ANDERSON.
Brooklyn, N. Y.

■

Removing Rusty Fittings from Pipe

From time to time considerable quantities of iron pipe of all sizes up to about 3 in. accumulate in our scrap pile. We try to salvage as much as we can, particularly the brass and iron fittings and valves. However, it is often practically impossible to remove fittings that have become rusted on, although they are otherwise in good condition. I wish that readers would tell me the methods they have found most effective in loosening up rusty valves and fittings, so that they can be removed without too much distortion and effort.

Milwaukee, Wis. **P. J. D.**

REMOVAL of rusty pipe fittings usually requires an abundance of effort under the best of conditions, but often much of this effort is wasted in twisting and distorting the pipe before the fitting will start. This is particularly true when fittings are not held close to the vise jaws. The grip of an ordinary three-jaw vise is limited to the width of the top jaw, usually not more than ½ in., and this is hardly sufficient to prevent twisting.

A set of two similar V-blocks, 6 or 8 in. long with four V-notches in each block will, when used inside the regular jaws of a machinists' or three-jaw pipe vise, serve as an excellent means of clamping pipe. These blocks should have slots the size of the jaw slots in an ordinary pipe vise cut in them over the entire V-surface.

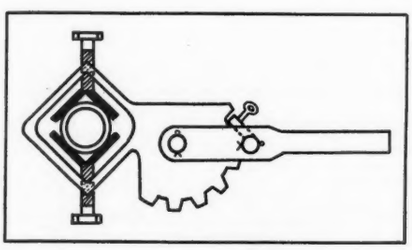
As an additional aid in the removal of hard-to-start fittings, a small chain block on an overhead trolley rail will permit a man to keep a steady pressure on the fitting while he strikes the pipe or fitting a few light blows with a hammer, to jar the rust loose.

Whether heat or so-called penetrating compounds should be used is a broad question. Removal of cast-iron fittings must be accomplished within a reasonable time, in order to make the undertaking profitable. The time required for penetrating compounds to do their work, and the quantity needed, at the prices charged, greatly restrict their use.

Application of heat to cast-iron fittings has many disadvantages. It is general opinion today that cast-iron fittings subjected to temperatures above 500 deg. F. show a permanent increase in dimensions, until the break-down point around 800 deg. F. is reached. To permit easy removal requires heating a fitting to a very low red color, denoting a temperature of about 800 deg. F. Aside from distorting the fitting, the application of a sufficient amount of heat may require more time than is allowable to make the salvaging profitable. Furthermore, fittings removed after heating to a high temperature are likely to be out of round, out of angle, and out of plumb, depending on their character and design. When they are used, trouble is almost certain to be encountered in the form of leaky joints, and poor appearance.

If the fittings are other than cast iron, the case is different. Also, if a pressure-tight joint is not essential, as in conduit work, heat will usually hasten the removal of the fittings, and will pay if it can be applied economically.

The sketch shows a wrench, preferably forged, that is a great help when much of this work is to be done. When a fitting is gripped it should not be released by the wrench until it is easy to turn. This is important, but not always possible with stillson and monkey wrenches, which have to be changed for convenient grips. In the wrench shown, the setscrews clamp V-notched, V-shaped jaws that hold the fitting. These jaws are removable, and the ratchet and pawl permit changing grips without removing the wrench.



Special wrench for facilitating removal of rusty pipe fittings.

Such a wrench used with V-block vise jaws to hold the pipe rigid permits rapid removal of fittings with only a small percentage of broken or cracked parts.

WILLIAM ANDERSON.
Pipe Shop Foreman,
E. W. Bliss Company,
Brooklyn, N. Y.

■

Changing Speed of Slipring Motor

I have a G.E. slipring motor, type MTC 5201, form C, 1,200 r.p.m., and want to speed it up by changing it to a four-pole machine. There are 72 slots in the stator and 54 slots in the rotor. The coil span of the stator is 1 to 11, and 1 to 10 in the rotor. Is this change practicable? Will the coil span or number of turns in the winding have to be changed? If so, what will the new data be? Any information you can give me will be appreciated.

Birmingham, Ala. **T. F. T.**

RECONNECTING the present winding will be the cheapest way out. This procedure will not give a highly efficient machine, but as this motor is presumably used for crane or other intermittent duty it will have rest periods that will keep the heat down.

Raising the speed would normally increase the output to 15 hp., as it is now 10 hp., but the increase will be cut down about 15 per cent because the coils are of such short pitch. I would not recommend reconnecting for constant duty.

As the connection now is there are eighteen groups of four coils each in the stator, with the probability of a delta connection for 220 volts. The rotor has eighteen groups of three coils each, ordinarily connected star.

When reconnected for four poles there will be twelve groups of six coils each in the stator, but as the rotor coils are not divisible evenly by twelve the grouping will be uneven, consisting of six groups of five coils each and six groups of four coils. If the rotor has a lap winding the regrouping will be easy. If it is wave-wound all of the bars on the connection end will have to be unsoldered and two sections grouped for five and two sections for four. It will be necessary to tie these sections together by a jumper.

Presuming that it operates now on 220 volts, if the motor is speeded up to 1,800 r.p.m. the factor for voltage change would be 1.5. However, due to the short coil pitch the chord factor would be 0.76, calling for about 250 volts. If the transformers are provided with taps the voltage may be raised to this value; if not, the motor would have to operate about 15 per cent under voltage.

If the reason for changing the speed is to secure more power, about 3 hp. will be gained. If greater horsepower and more reliable operation are needed, a rewind will be necessary. This will cost considerable, as new coils will be necessary for both rotor and stator. In fact, as this motor is the largest size built in frame 5201, the desired change may not be possible because of frame limitations.

Birmingham, Ala. GRADY H. EMERSON.

■

What Will Be Corrective Capacity of This Machine?

We have a 125-kva., three-phase, 80 per cent power factor waterwheel generator and wish to float it on the line as a synchronous condenser during periods of low water. Will this generator, when operated as a condenser, have the same corrective capacity as an 80 per cent leading power factor synchronous motor of the same rating?

Northampton, Mass. **L. C. D.**

A WATERWHEEL generator rated 80 per cent power factor will, when floated on the line as a synchronous condenser, have practically the same corrective capacity as an 80 per cent leading power factor synchronous motor of the same rating.

A machine of the rating given, running as a synchronous condenser, will supply approximately 75 per cent of its rated kva. input, in leading reactive kva. In the present case this will mean 75 per cent of 125 kva., or approximately 94 leading reactive kva. for correction.

General Engineer, R. P. GUILDFORD.
Westinghouse Electric & Manufacturing Company, Philadelphia, Pa.

A COMPLETE answer to this question can not be given without having all the data relating to the losses in the combined unit; that is, the friction, windage, and core losses in the generator, and the friction and windage losses in the turbine. It is assumed that suitable provision can be made for taking care of the turbine, so far as its bearings are concerned, and for breaking the vacuum in the draft tube.

The weight of the elements in such a generating unit, built to deliver power, is much greater than in one built especially to correct power factor, where the losses may be less than 5 per cent of the total kilovolt-ampere rating.

In one case, tests made on a 250-kva. generating unit showed an energy consumption of more than 10 per cent, whereas the limitations of the field made the corrective effect negligible.

It is recommended that the question be referred to the manufacturers of the generator and turbine for a reliable answer.

C. O. VON DANNENBERG.
New York, N. Y.

PREVENTIVE MAINTENANCE

J. A. WILLIAMSON
Acting Superintendent, Paper and Cloth Plant No. 1
The Carborundum Company
Niagara Falls, N. Y.

PLANT maintenance, as a function of plant operation, should be organized and conducted on a business basis, in accordance with a program acceptable to all departments concerned. With maintenance emphasized in this manner there can be no legitimate excuse for any plant, regardless of the nature of its product, to suffer an average lost-time per operation of more than a fraction of one per cent on account of mechanical failures.

Maintenance is referred to here as the function of maintaining operating equipment in an efficient producing condition. In preventive maintenance attention is concentrated on preventing failures or their reoccurrence. This kind of maintenance really pays dividends, because costs are kept low. If the cost of lost production, owing to mechanical failures, were calculated and charged to the maintenance account it would constitute a major portion of that account and might exceed the direct maintenance cost.

To the cost of lost production must be added the direct maintenance cost, which is made up of material, labor, and overhead. There must be added, also, the losses incurred from spoiled or imperfect products because of improperly maintained equipment, and an indirect loss in efficiency and energetic attack resulting from the effect upon operators, maintenance men, and management when breakdowns are prevalent.

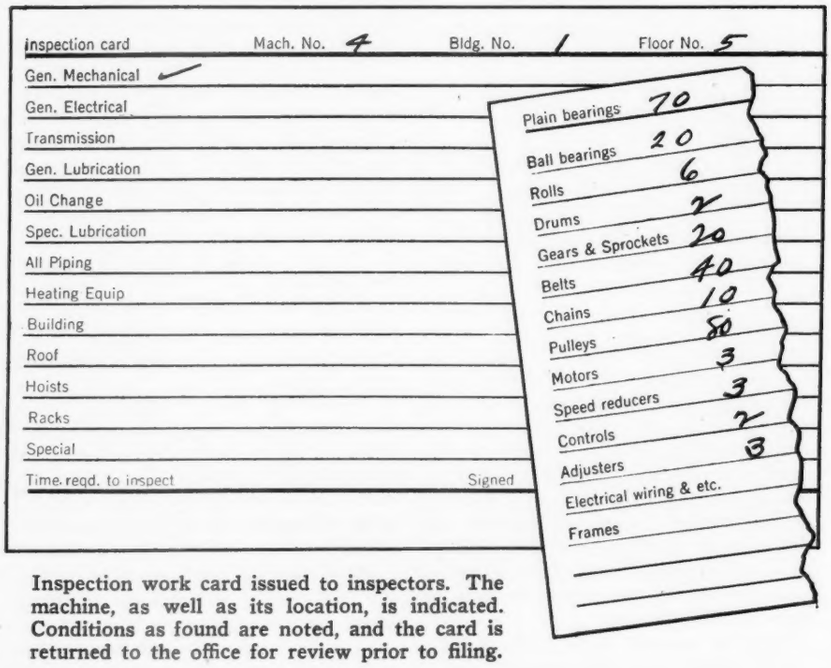
The plan is based on a system wherein structures, mechanical equipment, power generating and transmission equipment, piping, fixtures, conveying and transporting mediums, grounds, etc., are serviced as a result of the findings of regular periodic inspections, the periods depending upon the equipment and the service it performs. It should not be necessary for a superintendent to call a maintenance man to adjust a clutch, or a pipe fitter to tighten a packing gland, or an oiler to cool a hot bearing or fill a reducer with lubricant, during production time. Preventive maintenance makes such procedure unnecessary. In any plant the maintenance man should determine beforehand when replacements or repairs are necessary, and take care of them without further ado.

To be of value and successful in its purpose, the maintenance record necessarily must be simple. Our choice was the visible type of file with inserts as shown in the illustration.

The bottom of the insert is divided into 52 spaces representing weeks of the year. These serve to indicate, by means of a green celluloid movable tab or flag, the scheduled week or date when a particular inspection is due.

The frequency of these inspections, as previously determined according to the nature and use of the equipment, is indicated at the right by a number signifying weeks. In case of special consideration being required a red flag may be used to indicate a special inspection. Proper spaces are shown for indexing the equipment.

Near the top of the card is a similar division for 52 weekly periods, with a vertical index which is good for at least five years. The purpose



Inspection work card issued to inspectors. The machine, as well as its location, is indicated. Conditions as found are noted, and the card is returned to the office for review prior to filing.

of it is that in case an inspection work card, which will be described later, is returned marked O.K., a check mark can be recorded in the proper location indicating the inspection completed and conditions found satisfactory. If the inspection notice is not recorded, and if extensive repairs have been made, an index number may be recorded and under it a brief entry can be made describing the nature of the repairs.

There is also space on the insert for a brief description of the equipment and the necessary specifications for spare parts, supplies, special items, and type of inspection necessary. More extensive records or information may be recorded on the back of the insert, if desired.

A separate insert or card should be used for each unit or section of equipment including all types previously mentioned. In addition, a separate insert should be used for each distinct inspection function such as mechanical inspection, lubrication, or oil change. These functions may be consolidated on one card and distinguished by colored flags; however, that will be less satisfactory.

An inspection work card, which is shown, is filled out properly when the flag on the insert indicates that an inspection is necessary. On this card are shown spaces for equipment location, and an index of all general types of inspection, one or a number of which can be checked to indicate the type of work to be done, thereby eliminating written instructions by the clerk.

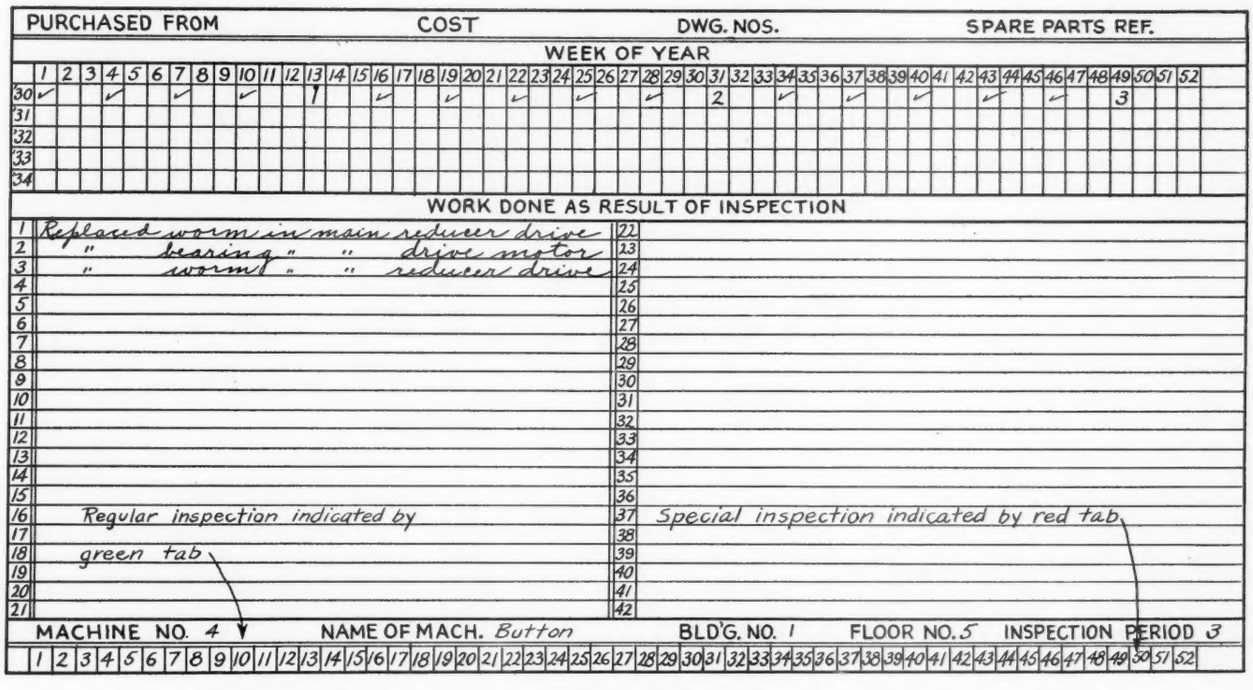
After all equipment has been indexed and catalogued as described, inspection periods determined and the flags arranged so that all work does not fall due at one period, the system is ready to be operated. The best arrangement is to have about the same number of jobs scheduled weekly.

A clerk supervises the schedule, and on Wednesday of each week determines, by means of the visible tabs, the necessary inspection, oilings, etc., to be made during that particular week. He then issues the necessary instructions on the inspection work forms to the master mechanic or foreman, according to the way the organization is set up, who in turn see that the necessary functions are performed wherever possible. Because the inspection cards are sent out on Wednesday, the majority of inspections are easily made within the week and the necessary repair orders are then issued for major jobs and the work is planned for week-end shutdowns. All inspection instructions are returned the first of the following week, unless held over by special arrangement. The instruction cards returned will bear the information found by inspection, such as O.K., oil changed, or certain repairs made, which information is entered in the file. If the condition is normal, a notation to this effect will be entered only as a check mark for record.

As a result all equipment is catalogued with a positive record of its condition and requirements. The tickler indicates when it will again be necessary to investigate the same territory.

An inspection of the record should show whether the repairs were of major or minor character; whether a separate cost record should be kept on single items; whether inspections have been regularly attended to, or if an abnormal number of special inspections has been required. Also, it may be found that the inspection periods should be lengthened or shortened. In addition to the foregoing, it sometimes brings about the necessity for the redesign of equipment and changes in structures.

A scheduled inspection program of this character should operate to reduce maintenance cost; insure 100-per cent operation, that is, no time lost on account of mechanical failure; increase production; decrease losses from material spoiled in process; provide a more uniform product; and in



Equipment index of the inspection system. Movable colored tabs indicate when general or special inspections are due. The card (6x11 in.) is good for a period of 5 years.

the operating department, induce an increased respect for and an appreciation of the value of continuous operation. The system operates with little attention other than energetic and conscientious inspections and promptness in the execution of the necessary repairs.

The man making the mechanical inspections must be a skilled mechanic or millwright. The inspectors on electrical equipment, service piping, and lubrication equipment also must be skilled in their line. The building inspections are made by an engineer or the master mechanic. The inspectors carry with them at all times sufficient tools to make minor repairs and adjustments as they cover their prescribed territory.

In connection with the system, brief remarks follow concerning the inspection of outstanding equipment.

Buildings or groups of buildings should be listed separately in the file, and the inspection periods set for intervals of from six months to a year, depending upon climate, age, foundations, and equipment housed. The inspection of the building proper should cover in detail foundations, walls, columns, girders, and building joints, etc. Location of all cracks should be determined and recorded. A case illustrating the foregoing was that of an old, brick building in which was installed a large amount of equipment producing considerable vibration. At the point where two columns rested on their footings there was noted an indication of slippage. These data were recorded and a point was located for subsequent measurement. The movement over the period of one year was so great that it was found necessary to reconstruct the foundation for this section.

Roofs should be listed separately in the file, and the inspection periods should be set from six months to one year depending on climate, age, and construction. Inspection should be conducted by a competent engineer to determine the necessity of repair or complete renewal.

Floors should be carried in separate groupings in the file by buildings or groups of buildings and inspected, depending, of course, upon their use, in periods ranging from three months to two years.

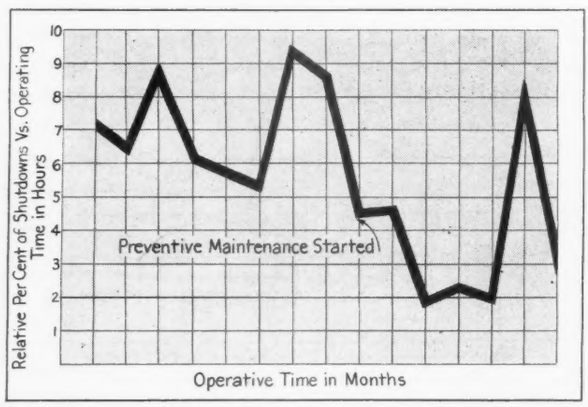
Paint should be checked at stated intervals, six months or more, taking into consideration protection, light-reflecting capacity, and cleanliness.

Electrical power transmission equipment should be inspected in periods of three months or less to insure dependability.

Power control equipment should be listed separately or in groups or territories and inspected according to use, the periods ranging from four to twelve weeks.

Lighting equipment should be inspected in periods of six weeks or less.

Heating equipment and low-pressure steam lines should be covered by thorough inspections every month.



Shutdowns are figured as a percentage of operating time and plotted as shown. The curve indicates better operations following the institution of the maintenance system.

High-pressure steam equipment should receive attention in semi-monthly or weekly periods.

Protection equipment, such as sprinkler lines, fire apparatus, and accessory equipment, should be checked over thoroughly in intervals of from three to six months. Some portions, however, require inspection more frequently.

Fixtures, such as elevators, require not less than weekly inspections, covering both mechanical and electrical equipment.

Materials-handling equipment, such as hoists (air and electric), must be covered by weekly inspections. Process materials-handling equipment should be inspected in semi-monthly periods, depending upon usage.

Transmission equipment, such as line shafting, should be covered by monthly inspections, with alignment checked at least every three months. Other heavily loaded transmission equipment should be inspected weekly.

Equipment such as machine frames, rolls, foundations, and bases should be thoroughly inspected for flaws and checked for alignment in periods ranging from two to six months.

Oil well bearings or any oil-reservoir equipment should have the oil removed, the equipment flushed with kerosene, and clean oil put in in periods ranging from three months to a year, depending upon the service. Simple equipment can be used for oil removal, such as compressed air, syringes, or syphons. In many cases the change can be made while the equipment is in operation. The used oil often can be re-used after being properly filtered. The practice of replenishing the oil supply as it becomes low is, without question, unsound.

Machine lubrication involving oil and grease cups is not covered by the inspection file for daily work; however, it should be covered by inspections in semi-monthly or monthly periods as a check upon the lubricating efficiency.

Motor lubrication still remains a topic of discussion as to whether it should be handled by the electrical or the lubrication department. No matter how it is handled it is well to have it covered by the maintenance inspection records and controlled in semi-monthly and monthly periods.

Sight must not be lost of the fact that the inspection system is installed for the purpose of insuring efficient operation of equipment and for providing against breakdowns which will interrupt production.

The plant engineer must defend the system and be enthusiastic in its execution. He must impress his master mechanic and other responsible members of his staff with the necessity for its adoption, and they in turn must do the same with the inspectors under their jurisdiction.

When such a program is launched it will bring to light weekly a series of maintenance repair jobs that will try the patience of all concerned for some time, but once a plant is put in efficient mechanical condition those jobs will be of minor consequence. No matter how insignificant the job, it must be completed promptly so that there will be no troublesome accumulation of work.

The thought presented here is to place maintenance on an offensive basis which we do by the application of the principles of preventive maintenance.

The Electric Eye Helps Make Steel

A. L. KRAUSE
Industrial Engineering Department, General Electric Company
Schenectady, N. Y.

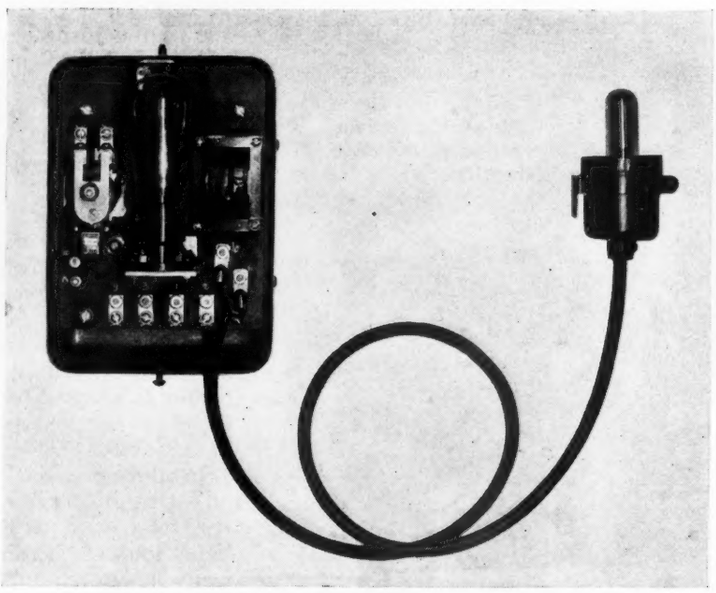


Photo-electric relay unit comprising a photo-electric tube (at the right), amplifier tube, sensitive relay, and control relay.

IT is quite natural that the photo-electric tube and its associated tubes, the pliotron and the thyratron, were at first looked upon with distrust by steel mill operators unfamiliar with the results that could be obtained by their use. Being of glass construction, they were assumed to be delicate, fragile things fit for use in laboratories only. It is now realized, and being well demonstrated by the increasing number of applications, that these tubes are by no means out of their element when placed in service in steel mills.

The photo-electric tube is a vacuum, or an inert-gas-filled tube by means of which light can be made to control the flow of electric current. In general, it contains an anode in the shape of a small wire and a cathode in the shape of a curved plate covered with a photo-sensitive substance, such as caesium or lithium. The photo-sensitive substance has the property of emitting electrons in proportion to the amount of radiant energy, including light flux, falling upon it. If the cathode is made negative with respect to the anode by the application of the proper voltage, the electrons will pass over to the anode. The maximum current that can be made to pass through the ordinary tube under normal conditions is quite small—in the neighborhood of 20 microamp. at the most.

The output of the photo-electric tube may be fed to a pliotron, a three-element tube whose output can actuate a sensitive relay, if such a device is suitable to the application, or the pliotron may act directly on the grid of a thyratron (a mercury-vapor-filled power tube), the output of which may be a million times the output of the photo-electric cell. An accompanying illustration shows a typical photo-electric relay combination, consisting of the photo-electric tube (without its protective hood) and the associated apparatus, the pliotron, sensitive relay, and the control relay. Another illustration shows the complete unit, including the photo-electric tube, mounted in a weather-proof case.

For many applications the light source may be an ordinary Mazda lamp, with or without a reflector or shield, but for applications where a higher light intensity is required or, where it is necessary to mount the light source and photo-electric tube a considerable distance apart, standard light sources have been developed. These can be obtained in both indoor and outdoor types that can be used with a 21-cp. automobile lamp for distances up to 25 ft., and with a 32-cp. lamp for distances up to 30 feet. The outdoor type is illustrated.

The photo-electric cell does not "see" things in the same manner as the human eye. The chart shows the relative sensitivity of the human eye and of a typical photo-electric tube to lights of different color, but of equal energy. The curve for the photo-electric tube varies considerably if different photo-sensitive substances are used. It is affected also by the glass of the tube, which tends to cut off the shorter wave lengths. Note the strong response given to red and infra-red light by this particular type of tube. A tube with these characteristics would be particularly sensitive to the light emitted from a heated ingot.

In general photo-electric tube appli-

cations may be divided into three groups, each requiring a different set of operating conditions.

First, are those applications in which the tube simply acts as an "on" and "off" relay. In the second group, the tube acts as an indicating device whose output is a linear function of a light flux when the actual change in light intensity is slow. The third group includes those applications where the frequency of light variation is high and the tube output must be an exact reproduction of this variation. This last group may be dismissed from discussion here, as it finds application primarily in television and in most of the present-day "talkie" movies.

The "on-off" relay application is by far the simplest of the three groups. For this work, variations in the line voltage, in the intensity of the light source, and in the characteristics of the tubes, are of small importance. It is one of the features of the application to have either an abundance of light flux, or practically none.

An application of this class has already been made in a steel mill in the Chicago district, using the relay in connection with the soaking pit crane to control the raising and lowering of the soaking pit covers. The photo-electric tubes controlling a cover are mounted along the runway directly over that cover. In line with the row of photo-electric tubes is a bank of lights mounted on the end of the crane. When the operator spots the crane over a pit from which he wishes to remove the cover, he steps on a foot switch that lights the bank of lamps, which in turn causes the proper photo-electric relay to energize the control operating that soaking pit cover. After removing the ingot from the pit the operator again steps on the foot switch and the second flash of light acts through the photo-electric relay to reverse the motor operating the soaking pit cover, and the cover is replaced.

In this instance a beam of light has replaced the sectionalized trolley system.

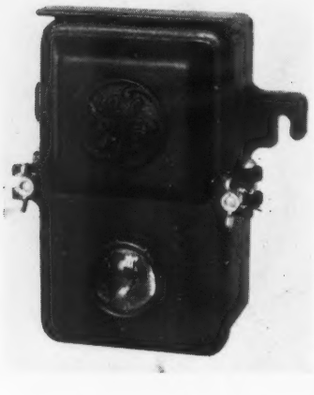
Possibilities in the use of the photo-electric tube as a limit switch are well demonstrated by the number of applications that have been made. In one of the large tube mills, a photo-electric tube was successfully used on a pipe facing machine. It was desired to move the cutting head toward the pipe at a high speed, and stop it ¼ in. from the pipe. Various types of switches were considered, but were discarded in favor of the photo-electric tube. The tube and its light source were mounted on the cutting head in such manner that when the head reached the desired distance from the pipe, the latter intercepted the beam of light and thus, through the action of the tube and the control equipment, stopped the motor driving the cutting head.

This application of the photo-electric tube was one in which great accuracy was required, and was made in spite of the fact that one would expect metal chips to fly from the cutting head and endanger the tube.

Another advantage of the photo-electric tube as an "on-off" relay arises from the fact that, whereas some pressure is required to operate a mechanical limit switch, no effort whatsoever is needed to interrupt a beam of light. An application in which this was the determining factor was recently made on a conveyor type of furnace. This furnace was used to heat-treat very light material. When the material being heat-treated reached the end of the furnace it struck a lever which, in turn, operated a limit switch to stop the conveyor driving motor until the operator removed the first plate of parts; then the conveyor would automatically start up and run until the next plate struck the lever. However, instead of operating the limit switch the plates would, upon striking the lever, sometimes slide back. To correct this difficulty, the limit switch and the lever were replaced with a small target balanced on the end of the lever so that an exceedingly small amount of pressure from the steel plate in the furnace could readily move the lever. The target on the end of the lever outside of the furnace was arranged so that it intercepted a beam of light directed onto a photo-electric tube. The tube circuit was arranged in the usual manner to stop the conveyor motor.

Outdoor type of photo-electric relay, for service where the conditions are severe.

Light source, outdoor type, for photo-electric relay.

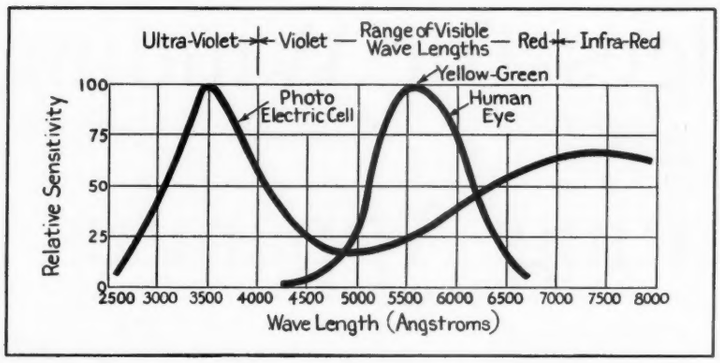


There are no doubt many operations in which the product being made is not sufficiently heavy to actuate a mechanical limit switch, that could readily be adapted to use the photo-electric type of limit switch.

In addition to the "on-off" type of photo-electric relay with its own light source, there are many applications in steel mills where the light from an ingot or other heated metal could be used to actuate the relay. In fact, the photo-electric relay is used in one mill to count ingots as they approach the rolls. The cell is mounted about 10 feet from the ingot and operates an electric counter each time an ingot passes.

In the same mill a photo-electric relay is used to operate a solenoid valve that turns on the water spray to remove the scale, as the slabs leave the rolls. In this case the tube is mounted on the roll stand; when the slab passing through the rolls reaches a certain point, the light from the slab operates the photo-electric relay.

As previously mentioned, applications of the photo-electric tube can be divided into three groups, of which we are concerned with two only. The examples given above belong to the first group. In the second group—where the tube acts as an indicating



Relative sensitivity of the human eye and of a typical photo-electric tube to lights of different color, but of equal energy value.

device whose output is a linear function of the light input—the applications are not so numerous. Under this group would be considered the application of the photo-electric tube as a pyrometer. The light from a heated ingot varies at a rate much higher than the first power of the temperature. Thus, minor errors in the relay calibration itself would mean correspondingly smaller errors in the indicated temperatures of the ingot.

There are possibilities here for the use of photo-electric relays as a means of recording the temperature of ingots as they pass a given point. Or, if desired, means could be provided for preventing an ingot from entering the rolls unless it has a temperature between a desired maximum and minimum.

BOOKS

Underground Systems Reference Book

Published by National Electric Light Association, 420 Lexington Ave., New York, N. Y. Imitation leather, 8¾ by 11½ in., 400 pages, illustrated. Price, to members, $4; to non-members, $6.

PUBLICATION of this book has been under discussion for nearly six years. It has been compiled by a staff of well-informed engineers, and presents a great deal of valuable data for the man in the field, as well as in the office.

The introduction contains a non-technical, historical review of the development of underground systems. It is interesting to note that their installation dates back to 1812, when Baron Schilling fired a mine under the Neva by an electric impulse sent through a cable insulated with strips of India rubber.

Succeeding chapters cover such subjects as cable and cable insulation, conduit and manholes, cable installation, cable splices and terminals, cable operation, miscellaneous equipment for underground installations, and safety practices. There is an appendix of general information, and a complete bibliography of the literature on cables and underground practices. These references have been well classified and indexed for convenient use.

This is the first time that authoritative data on planning, constructing, and operating underground systems, based on successful methods and practices of operating companies, have been published in reference book form. The present work should be a most valuable addition to the library of everyone concerned with underground systems.

■

Instructions for Care and Operation of Transformers

Published by National Electrical Manufacturers Association, 420 Lexington Ave., New York, N. Y. Fifth edition, 15 pages. 25 cents.

THIS handbook represents the recommendations of the Transformer Section of the National Electrical Manufacturers Association, the member companies of which Section produce the great majority of the power and distribution transformers used in this country.

Treated in the contents are such topics as location, handling, inspection and storage of transformers, directions for drying coils and cores, sampling, testing and drying oil, and filling transformers.

Inasmuch as successful operation and satisfactory service from transformers is dependent upon proper installation and usage as well as correct design and manufacture, the information presented in this book, which has been carefully revised and edited to contain the latest available data, will be found highly useful by everyone concerned with the installation, operation, and maintenance of such equipment.

■

Patent Law for Chemists, Engineers and Executives

By Fred H. Rhodes, Prof. of Industrial Chemistry, Cornell University, Ithaca, N. Y. McGraw-Hill Book Company, Inc., 370 Seventh Ave., New York, N. Y. Cloth, 207 pages. Price, $2.50.

MODERN industry has long realized the necessity for developing new products and processes to insure profitable operation. In cases in which such advances have been due to inventions, both executives and investigators have shown a surprising lack of familiarity with the laws enacted to protect the results of their efforts.

Much useless toil, legal litigation, and injustice would be avoided if all concerned with invention were possessed of the thorough general knowledge of patent law offered in this book. What may be patented, how it may be patented, and who are entitled to patents are explained in a manner avoiding technical legal terms as far as possible. Important points are substantiated by illustrative citations from court decisions in typical patent cases. Rights of the employer and employee are clearly defined.

■

Lumber and Its Uses

By Royal S. Kellogg. Scientific Book Corporation, 15 East 26th St., New York, N. Y. Fourth edition, flexible binding, 378 pages, 100 illustrations. Price, $4.

LIKE its predecessors, the latest edition of this book covers the properties and applications of the principal species of wood which are manufactured into lumber. Its value to manufacturers, handlers, and users of lumber, and to others concerned with the lumber industry, has been enhanced by the revisions and additions necessary to include the latest developments in technology, applications, and manufacturing technique. Additions include the recently adopted American Lumber Standards and considerable material, both text and illustrations, on the uses of lumber for general construction purposes. Of especial interest to plant and maintenance engineers are chapters dealing with factory uses, preservation, paints and finishes, fire resistance, and general construction.

Slot Wedges for Windings of Rotating Apparatus

By A. C. ROE
Renewal Parts Engineering Department
Westinghouse Electric & Manufacturing Company
East Pittsburgh, Pa.

MANY of the armatures used in d.c. motors or generators employ special-shaped, machined wedges to retain the windings in the slots. The manufacturing, testing, and proper installation of these wedges are important factors. The function of slot wedges in d.c. armatures or a.c. rotors is to hold the coils rigid and tight in the slots; bands of steel or bronze wire are used to retain the end windings. Where high peripheral speeds or severe service requirements are encountered, core bands are used; in some cases wedges and both core bands and end bands are used.

Wedges may be made from either fiber or Micarta. The Micarta wedges have greater mechanical strength, and are quite impervious to moisture. Hence, they can be stored with reasonable assurance that they will be usable when needed. Micarta requires more care in machining and installing.

Factory-made fiber wedges are rough-cut, machined to shape and size, and then treated in paraffine or varnish. These wedges are held to very close limits, allowances being made in the rough and machine cuts for shrinkage. Thus, when fiber wedges are to be stored for long periods, they should be kept where the air is dry and of a fairly even temperature.

Fiber is the material generally used for wedges, as the cost is low and machining easy. On the other hand, fiber absorbs moisture; hence, a well-cured and high-grade, uniform material must be used so that allowances and limits can be established to assure correct finished dimensions.

Most fiber wedges are treated by baking and then dipping while still warm in hot paraffine, which penetrates slightly and prevents moisture absorption. Dipping in varnish provides an outer protective coating which must, however, be kept intact in order to be effective. Fiber wedges should be stored in a dry place to prevent swelling or warping. Paraffined wedges may require drying for six to ten hours at 55 deg. C., before they can be used.

As mentioned in a previous article in the March issue, the slot insulation must be selected and applied so as to permit securing the coils tightly when wedging. In all cases, the winding cell should be turned over on top of the coils and, where possible, a strip of 1/32-in. fiber placed on top of the turned cell, under the wedge. This strip acts as a runner for the wedge and tightens the winding depthwise in the slot. These strips can be seen in Fig. 1 at the end of

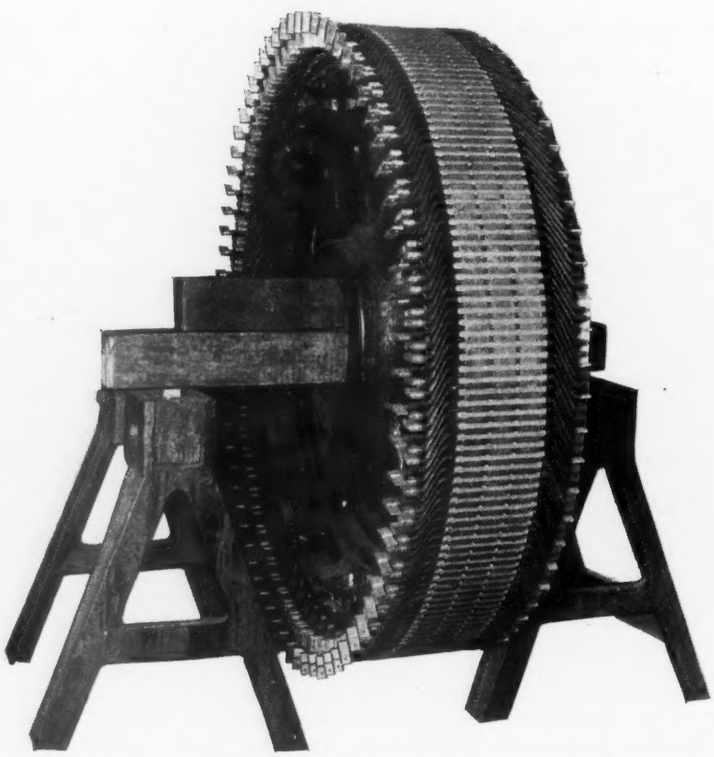


Fig. 1—Strips of 1/32-in. fiber placed on top of the turned-over winding cells, under the wedges, can be seen in this booster winding of a rotary converter booster set.

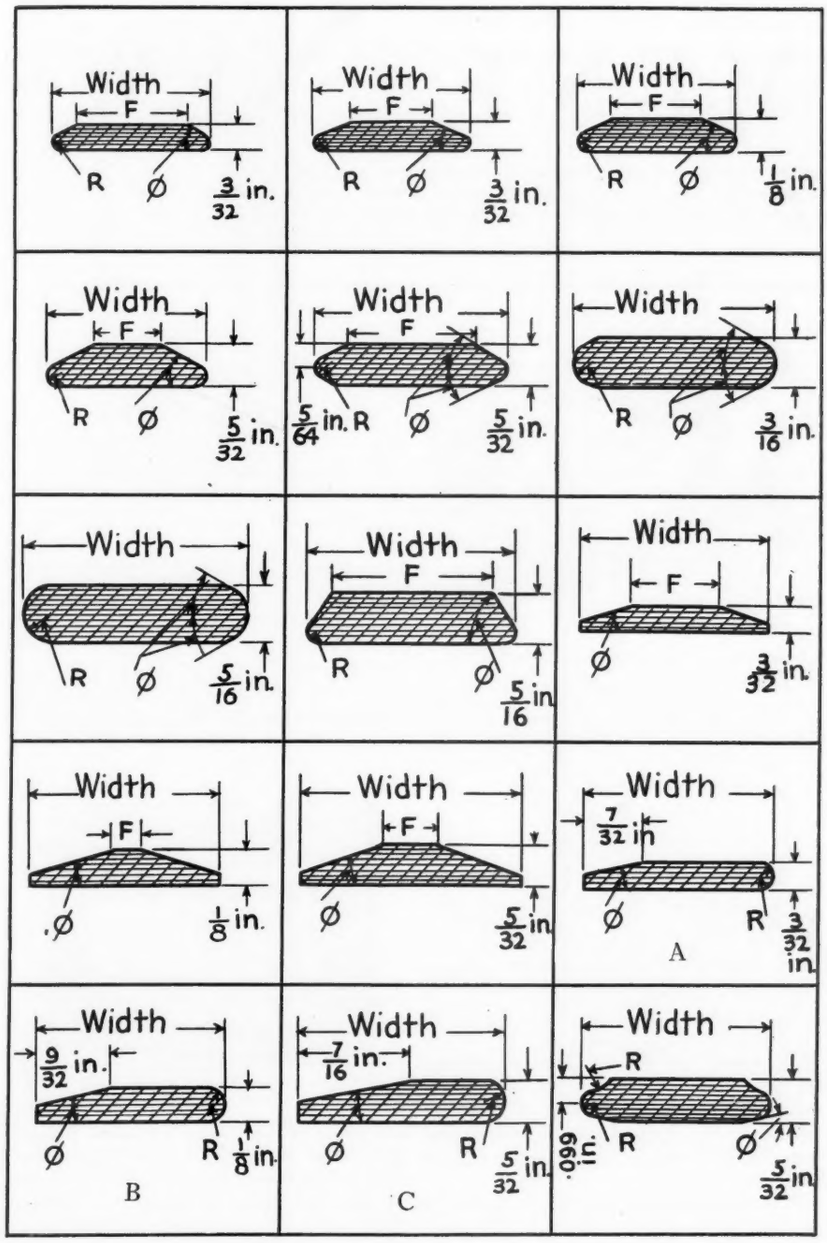


Fig. 2—Dimensions and shapes of wedges in most common use.

the wedges. The rotor shown is the booster winding of a rotary converter booster set.

Wedges are seldom made in one piece, or single length; it is customary to cut them into two, three, or more lengths, depending on the length of the coil. The shapes vary according to the width of the slots, speed of armature, weight of winding, and so on. In Fig. 2 are shown fifteen of the most commonly-used shapes. It will be noticed that the width of the flat top, *F*, depends upon the angle ø and the thickness of the wedge; also, that some have all corners rounded, whereas others have square corners, or combinations of both. The three wedges with the angle on one side only, as *A*, *B*, and *C*, in Fig. 2, are used in overhung slots of a.c. rotors having threaded-in windings.

A study of Fig. 2 should impress one with the importance of securing the proper wedges with angles ø, corner radii, thickness, and so on correctly proportioned to fit the slot so that the wedge can be driven in with the minimum of grabbing or scraping of the laminations.

To obtain a tight winding depthwise, without damaging the wedge or making excessive pounding necessary, a steel spoon is used, of the shape shown in Fig. 3. Section *D* is machined to the same shape and dimensions as the wedge to be driven. Sections *B* and *C* are cut away to permit passing through the slot opening. The angle ø is chosen so that *B* and *C* will clear the slot.

When driving wedges the spoon is started in the slot first and driven part way across; then the wedge is driven in after it. Following this, the spoon

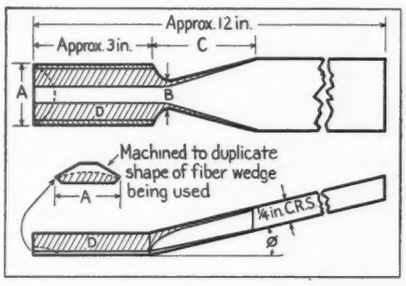


Fig. 3—A driving spoon that facilitates installation of wedges, and helps to prevent damage.

and wedge are advanced a few inches at a time. The use of the spoon forces the winding down and permits driving the wedge without damage. At the same time it insures a tight job.

In Fig. 4 is shown a double-deck, blunt-nose, wedge-driving tool. The thickness at *A* is selected to give a good, strong tool, whereas *B* is chosen to suit the thickness of the wedge, and *C* the width of the slot opening. This tool is used to drive the wedges across the slots, or to drive them out. The

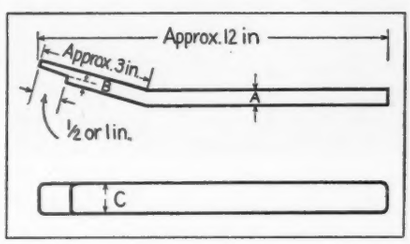


Fig. 4—Blunt-nosed driving tool for driving wedges across or out of slots.

upper end of the tool can be shaped to fit into an air hammer.

Wedging of armatures should be carefully done, precautions being taken to obtain a properly-fitting wedge. Then tighten the winding as much as possible, using tools and driving methods that permit entering the wedge with a minimum of pounding and scoring or scraping the wedge.

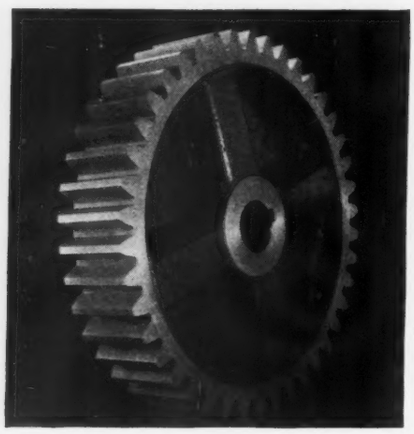
EQUIPMENT NEWS

Industrial plant executives concerned with the selection and operation of mechanical and electrical equipment will be interested in these devices, which are designed to improve plant operation or reduce operating and maintenance costs.

Philadelphia "Philweld" Gears

WELDED steel gears have been developed by the Philadelphia Gear Works, Philadelphia, Pa. The line, known as "Philweld," is available in diameters ranging from 15 to 168 in. and is designed for heavy-duty service.

Using rolled 1040 S.A.E. steel plate, the rim is cut in the form of a solid ring from the flat plate by means of a gas torch. A solid, rolled-steel disk forms the web of the gear against which the channel-shaped, pressed-steel arms are welded on both sides. The hub is a forged-steel bar drilled to receive the shaft. Hub, web, arms, and rim are welded into the finished structure, and the whole is normalized before machining.

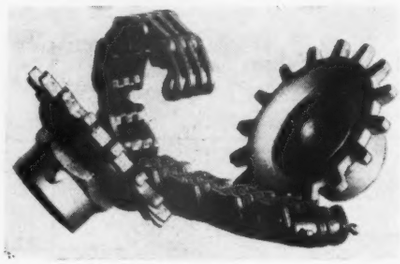


The entire line of cast-steel gears—spur, helical, herringbone, bevel, internal, spiral, and continuous herringbone gears (Sykes type)—are also available in welded steel construction. Likewise, heavy-duty, speed-reducer units, formerly using a cast-steel gear assembly, are now offered with "Philweld" gears if desired.

■

Morse "Midget" Couplings

MORSE Chain Company, Ithaca, N. Y., a division of Borg-Warner Corporation, announces a line of chain and sprocket flexible couplings,



known as Morse "Midget" couplings, available for shaft sizes up to 1 in. in diameter. Couplings consist of three steel parts—two sprockets wrapped by a chain.

■

Automatic Electric "Strowger" Time-Recorder

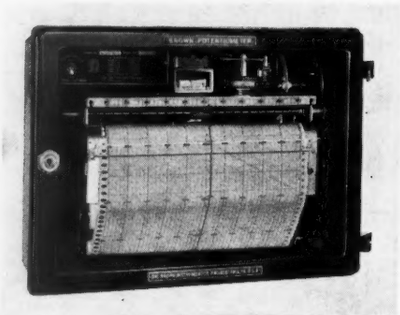
DESIGNED primarily for use in connection with watchmen's supervisory and police reporting systems but adaptable to other use, this electrically operated secondary clock, known as the "Strowger" Multiple Time-Recorder, has been announced by Automatic Electric, Inc., 1033 West Van Buren St., Chicago, Ill. It is timed by electrical impulses transmitted every minute from a master clock.

The instrument has a capacity of 60 stations connected to it by individual circuits. When the circuit is closed at any station a motor-driven mechanism prints a record of the operation. All parts are inclosed in a cast-aluminum case which may be locked and wired to record every time it is opened. When used for other purposes than watchmen's service a window is provided in the cover. The recorder contains a three-months supply of paper. It operates on 48-volt d.c. circuits.

Brown Potentiometer Pyrometers

POTENTIOMETER pyrometers have been announced by the Brown Instrument Company, Philadelphia, Pa. They are designed for use in the heat treatment of steel, brass and alloy parts; oil refining; and electric furnace control.

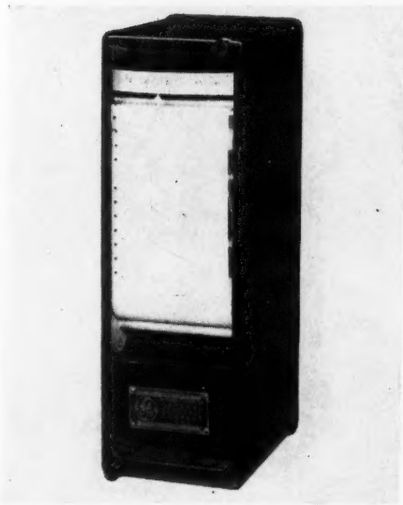
Charts and scales are 12 in. wide. A humidity compensator is built into the instrument which, according to the announcement, corrects the pen position for the expansion and contraction of the chart paper caused by changes in humidity. The instrument is completely inclosed in a case that is equally suitable for mounting on walls, standard panelboard, flush-type panelboards, or tables. A chart re-roll attachment is standard. Bearings are of bronze or nickel silver. The case, door and frame are enameled, aluminum die castings, and the door handle and lock are chromium plated.



■

General Electric Photo-Electric Recorders

RECORDING instruments, operated by photo-electric and pliotron tubes which are incorporated in them, have been announced by the General Electric Company, Schenectady, N. Y. The announcement states that the instruments have greater sensitivity and accuracy because the inking pen is not operated directly, but by a small high-torque element supplied from an auxiliary source of energy.



Directly beneath the recording element is an indicating instrument element. A photo-electric circuit and an optical system cause the recording element to follow the indicating element and make a continuous record of the deflection. In this manner any quantity which may be indicated can also be recorded. The only mechanical burden placed upon the indicating element is a small galvanometer mirror. These recorders are now available in types to correspond to practically any of the indicating instruments, such as ammeters, voltmeters, and indicating thermometers.

■

Troy Utility Lamp

ALL-PURPOSE utility lamps have been introduced by the Troy Manufacturing Company, 126 West Kinzie St., Chicago, Ill. Two models for industrial plant use are available; Model A, with a rubber keyless handle socket and Model B with a key socket. Both units are equipped with a patented swivel clamp which permits adjustment at any angle.

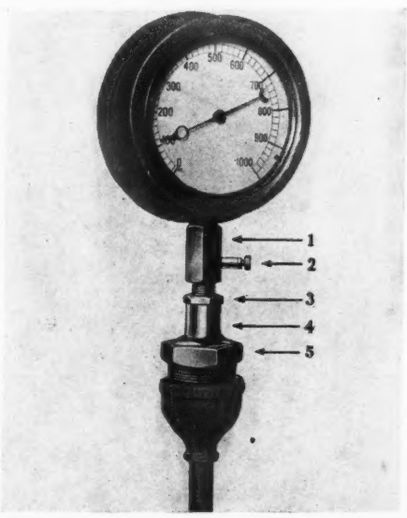
Ideal Adjustable Growlers

IN the notice in the May issue describing internal and external growlers made by the Ideal Commutator Dresser Company, Sycamore, Ill., the external unit was stated as operating on 110-volt 60-cycle current only. This statement applies to standard models only. Other voltages and frequencies are available on special order.

■

Champion & Barber Gage Protector and Non-Pulsator

TWO gage accessories, known as the gage protector and the non-pulsator, have been announced by Champion & Barber, Inc., 576 Subway Terminal Bldg., Los Angeles, Calif. The gage protector consists of three parts: a



bronze body, an acid-resisting pressure bulb, and a bulb retainer. Line pressures are transmitted to the bulb which in turn compresses the secondary-bulb liquid which acts on the gage. The fit of the pressure bulb is said to be tight enough to prevent line acids or solids from entering the gage.

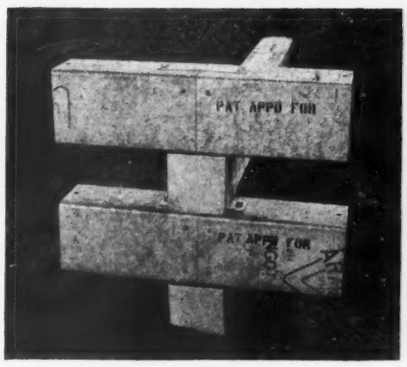
The non-pulsator operates on the principle of fluid restriction and is controlled by adjusting a needle valve. It is made entirely of bronze.

Instruments may be used separately or together.

■

Armco Ingot Iron Cribbing

METAL cribbing for retaining walls has been announced by the American Rolling Mill Company, Middletown, Ohio. The wall is built up from standard formed galvanized sections either six or eight ft. long, and



held together by an interlocking device.

Where closed face walls are desired, galvanized metal filler plates which fit in between the units may be used.

■

Jas. P. Marsh Acquires Radiator Valve Division of General Brass

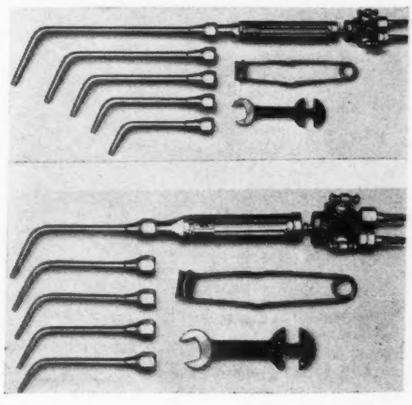
AN announcement recently issued by Jas. P. Marsh & Company, 2073 Southport Ave., Chicago, Ill., a division of the Commercial Instrument Corporation, states that they have acquired the radiator valve division of the General Brass Company, Detroit, Mich. Equipment from the Detroit company is being transferred to the Marsh plant in Chicago.

■

Linde Blowpipes

TWO WELDING blowpipes have been added to its line of Prest-O-Weld medium-pressure apparatus by The Linde Air Products Company, 205 East 42nd St., New York, N. Y. A detachable valve, to which the handle is secured by a locking device, enables the operator to change from the standard to different handles without detaching the hose or hose connections and without the use of a wrench. These units are known as types W-105 and W-106.

Both blowpipes are designed for use

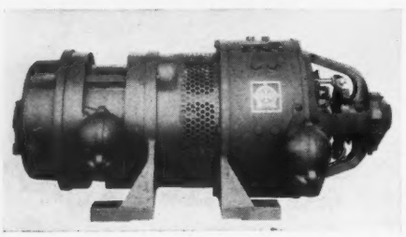


with one-piece, hard-drawn copper welding tips. Although regularly supplied with a head angle of 60 deg. this may be changed by the user to any angle desired. Ten different tips, Nos. 4 to 13 inclusive, are available for use with type W-105 handle. Type W-106 is similar in design and is supplied with five sizes of tips, Nos. 3 to 7 inclusive.

■

Reliance Motor-Generators

ONE-UNIT m.g. sets have been announced by the Reliance Electric & Engineering Company, 1088 Ivanhoe Road, Cleveland, Ohio. Sets can be furnished for operation on either two- or three-phase circuits of any standard voltage and frequency and have an out-

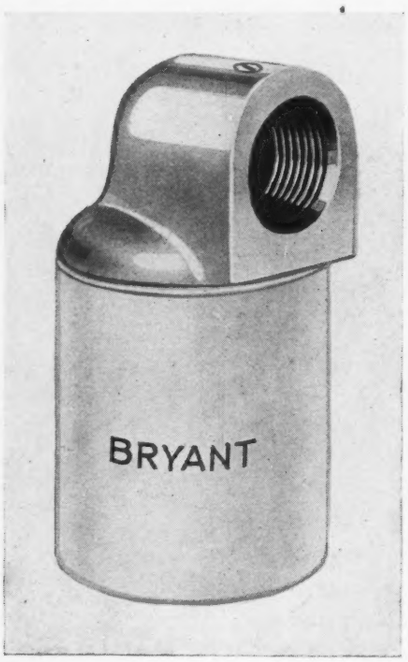


put rating of from 1 to 5 kw. at 125 or 250 volts. Ball or sleeve-type bearings may be used.

■

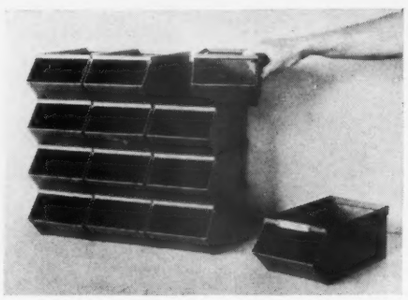
Bryant Porcelain Sockets

PORCELAIN sockets with die-cast heads have been announced by The Bryant Electric Company, Bridgeport, Conn. They are available in ½-in. and ⅜-in. sizes. Caps may be either straight or angle type.



Stackbin Nesting Bins

THE STACKBIN Corporation, Pearl and Rice Streets, Providence, R. I., has taken over the manufacture and sale of the entire line of nesting bins from the Simplex Tool Company.



These products will be known as Stackbins. The line at present comprises individual sectional-type nesting bins.

■

Paasche Air-Finishing Unit

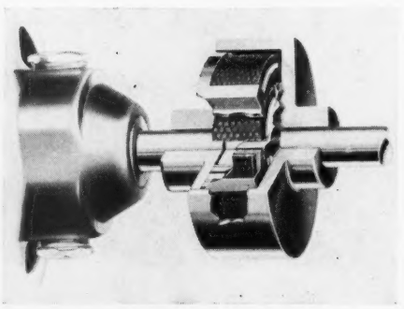
PORTABLE ½-hp. electric air-finishing units have been developed by the Paasche Airbrush Company, 1909 Diversey Pkwy., Chicago, Ill. They are

designed for use on all medium-size painting and finishing jobs. Features include a copper cooling coil with water and oil separator. The single-phase repulsion-induction ½-hp. motor operates on 60-cycle current at 110 or 220 volts. The motor, double-cylinder air compressor, and coil are mounted on a metal base equipped with rubber-tired rollers.

■

Worcester "Rawson" Automatic Starter and Flexible Coupling

USE of the "Rawson" automatic starter and flexible coupling will, according to the announcement, reduce starting loads and absorbs shocks, permitting the use of standard motors where special or large motors previously had been necessary. It is manu-



factured by the Washburn Shops of the Worcester Polytechnic Institute, Worcester, Mass. The unit consists of two cast-iron members, one attached to the drive shaft and another attached to the driven shaft. Between these members are inserted floating segments made of brake lining reinforced with lead.

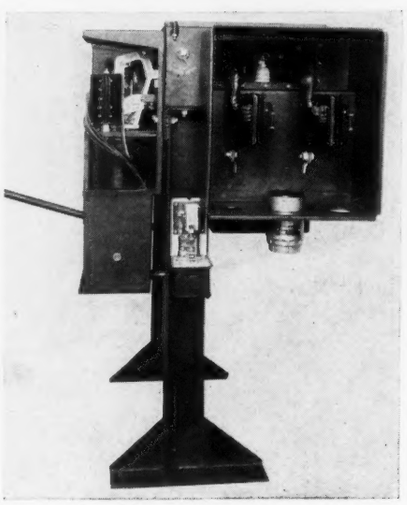
Starters and couplings are available in any size or capacity, and although they are generally direct-connected to electric motors, they may be furnished for gear, chain, V-belt, or flat-belt drives. They will operate in either a horizontal or vertical position, or in either direction of rotation.

■

Delta-Star Metal-Clad Switchgear

DELTA-STAR Electric Company, 2400 Block, Fulton St., Chicago, Ill., announces a line of metal-clad switchgear designed for controlling station auxiliaries such as pumps, fans, and other motor-driven equipment.

The two solenoid-operated circuit breakers are also provided with hand control. The current transformers for use with instruments and relays are located in a compartment provided with terminators for incoming and outgoing cables. The unit is complete with control relays for the closing coils, auxiliary switches, indicating lamps, trip coils, circuits, and electrical interlocks.

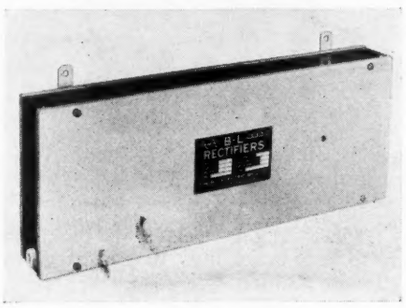


Breakers also may be provided with complete electrical or mechanical interlocks if desired. All parts are inclosed in a steel housing.

■

B-L Electric "Filterpacs" and "Rectopacs"

TWO types of power units, known as "Filterpacs" and "Rectopacs," for furnishing low-voltage direct current from a.c. lighting lines, have been developed by the B-L Electric Manufacturing Company, 19th St. and Washington Ave., St. Louis, Mo. Both units



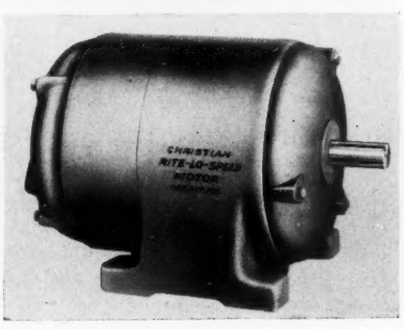
use dry-plate rectifiers to rectify the current from a step-down transformer and are inclosed in steel cabinets. The field of application for these units includes such types of equipment as clock systems, time stamps, signals, annunciators, and telephones.

■

Christian "Rite-Lo-Speed" Motors

INCLOSED motors with footless stators and rotors and heat-treated alloy-steel gears, known as "Rite-Lo-Speed" motors, have been developed by the J. D. Christian-Engineers, 512 Brannan St., San Francisco, Calif., in co-operation with the manufacturers of U. S. asbestos-protected motors. Gears are ball-bearing mounted.

Motors are available in four series: Series A is standard and consists of the motor and housing with a single power take-off; series B has a gear housing at each end and two power take-offs at the same speed; series C is the same as series B with the exception of having two power take-offs at different speeds; series D has the gear housing at one end, the power take-off at reduced speed, and a high-speed motor shaft extending through the rear end bell. Motors may be procured in sizes ranging from ¼ to 30 horsepower.

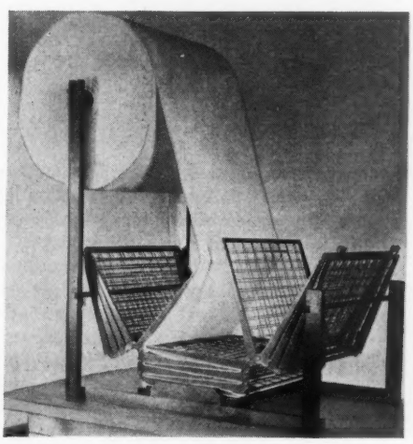


■

Independent "Compact" Air Filter

INDEPENDENT Air Filter Company, 29 South Clinton St., Chicago, Ill., announces a filter, known as the "Compact," for low-velocity air flow. It is designed for general ventilation, air cleaning, air-compressor, diesel-engine, and warm-air heating applications.

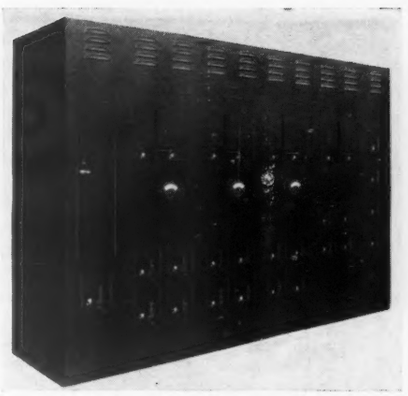
The unit consists of a series of superimposed, hinged wings or panels into which a continuous sheet of fabric or fibrous, filter medium is folded. Fabric is fed from rolls into the filter units when the useful life of the filter medium is at an end. Although a cotton medium known as "Filterdown" is recommended for general purposes, cotton, cellulose, wool felt, or asbestos may be used to suit requirements.



■

BullDog "Saftoswitchboards"

STANDARDIZED sectional switchboards, known as "Saftoswitchboards," have been announced by the BullDog Electric Products Company, 7610 Jos. Campau Ave., Detroit, Mich. Switchboards are of the dead-front, totally inclosed type and consist of steel panels and frames in which are incorporated ball-bearing switches known as "Saftoswitches." The switches permit



full-floating contact and embody separate fuse and switch compartments interlocked for safety in replacing fuses. Provision is made on the switchboards for the interchangeable mounting of switches of any desired polarity, capacity, and voltage. Air circuit breakers, oil breakers, and meters also may be provided for when required.

■

Bennett "Bondnut"

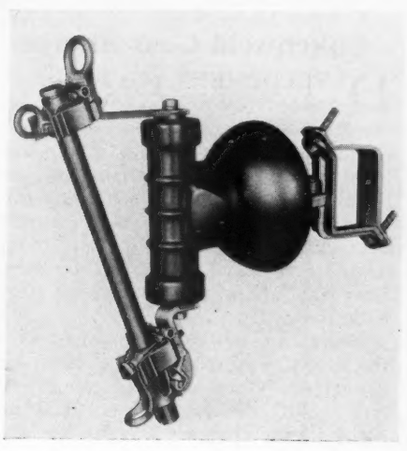
SHARP bonding spurs on the rim of the "Bondnut," announced by I. A. Bennett & Company, 753 West Jackson Blvd., Chicago, Ill., enable this device to make a metal-to-metal ground between electrical conduit and outlet or switch boxes. Elimination of loose connections owing to vibration is one of the features claimed by the manufacturer.

The device is locked in place by jamming one of the notches with a screwdriver.

■

Matthews "Fuswitches"

OPEN-TYPE fuse switches or cutouts, known as "Fuswitches," have been announced by the W. N. Matthews Corporation, St. Louis, Mo. One-piece,

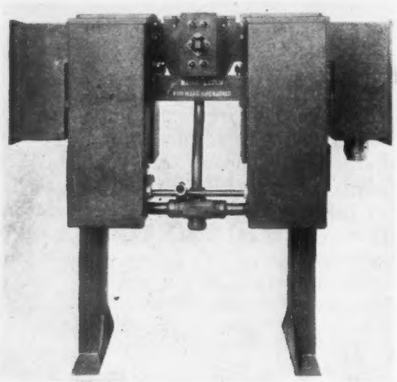


wet-process, porcelain insulators are said to give the instruments high flash-over values. Contacts are of bronze and are of the flat-surface pressure type. Screws, plugs, and other current-carrying parts are made of red brass. The cross-arm clamp-type hangers are so designed that the switches may be mounted at any angle and locked. Fuse links are the button-head type. Instruments are rated between 7,500 and 15,000 volts at 30 and 60 amperes.

■

Delta-Star Metal-Clad Switchgear

METAL-clad switchgear for power distribution, controlling-station auxiliaries, across-the-line motors, or similar service, has been developed by the Delta-Star Electric Company, 2400 Block, Fulton St., Chicago, Ill. This unit consists of two 7.5-kv., 600-amp. electrically operated, three-pole, oil-circuit breakers mounted on a steel frame and complete with current transformers and cable compartments.



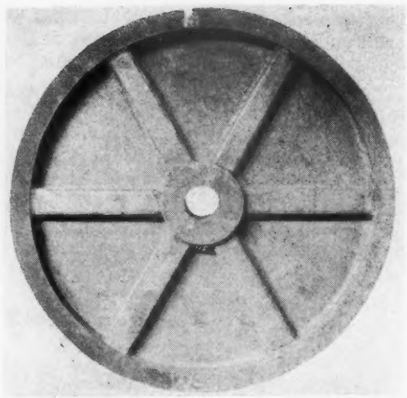
Breakers are mechanically and electrically interlocked so that both cannot be in circuit at the same time. Cable entrances are equipped with Terminators.

■

Lukenweld Gear Blanks

DEVELOPMENT of a line of all-welded roll-steel gear blanks has been announced by Lukenweld, Inc., Coatesville, Pa., a division of Lukens Steel Company. Spur, herringbone, and helical gears may be cut from the blanks in any size from 24 in. outside diameter up. Although blanks are ordinarily made from S.A.E. 1020 carbon steel, rims may be furnished in special steels if desired.

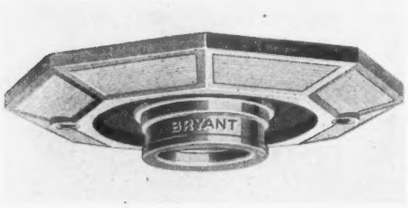
Hubs are gas-cut from steel of a thickness corresponding to the hub diameters. Webs and ribs are gas-cut from rolled steel plate, the ribs being formed into channels. Webs are arc-welded to the hubs and the channels to the webs. The final operation consists of the circular bending of the gear ring and arc-welding it into position. All blanks are then annealed.



■

Bryant Receptacle With Outlet Box Cover

A PORCELAIN receptacle with a brown screw ring combined with a brown bakelite outlet-box cover has been announced by The Bryant Electric Company, Bridgeport, Conn. The octagonal cover is suitable for 4-in. outlet boxes. The screw ring contains a shade-holder groove.



■

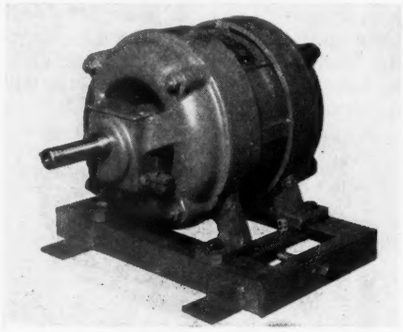
National "Flexlay" Cable

UNDERGROUND cable, known as "Flexlay," has been announced by the National Electric Products Corporation, Fulton Building, Pittsburgh, Pa. It is produced in three different types: non-metallic, semi-metallic, and full-metallic or "Parkway" cable. The announcement states that the cable may be laid in an open trench without damage from abrasive handling, and that it is constructed to adequately resist the action of soil textures, acids, and moisture in the soil.

Lincoln Motor Base

WELDED steel motor bases of one-piece construction have been announced by the Lincoln Electric Company, 12818 Coit Rd., Cleveland, Ohio.

These bases are designed to be used instead of slide rails. They are constructed of rolled steel angles and flat bar stock. Flanges of the angles to which the motor is bolted are slotted to permit moving the motor on the base for tightening the drive belt. At one end, a screw adjustment is provided for moving the motor on its base.

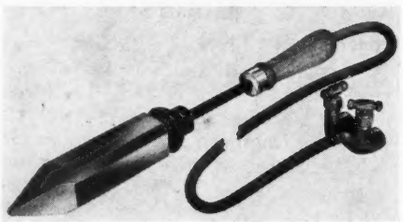


Drilled angles welded to the sides form hold-down lugs for securing the base in position.

■

Reliance "Torchiron"

A SOLDERING iron which is heated internally and, by the removal of the copper can be converted into a torch, has been introduced by the Reliance Specialties Manufacturing Company, 122 East 42nd St., New York, N. Y. The tool is heated by either natural or artificial gas, the amount of which is regulated by a mixing needle valve.

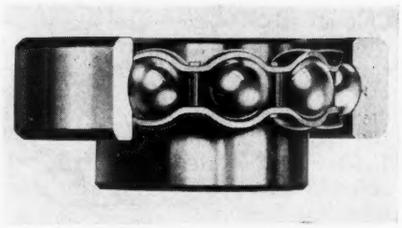


Sizes range from ½ to 5 lb. and are available in a wide variety of shapes.

■

Standard Wide Inner-Ring Bearings

STANDARD Steel and Bearings, Inc., Plainville, Conn., announce a line of bearings, known as SRB wide-inner single-row bearings. They are of the same design and dimensions as SRB single-



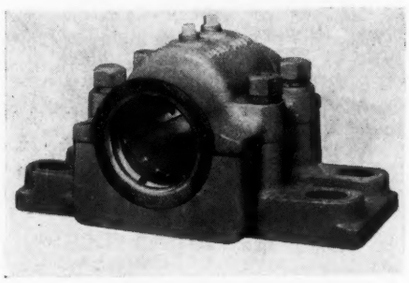
row maximum-capacity bearings except that the inner rings have the same width as that of the double-row bearings of corresponding sizes. The additional width of the inner ring permits the bearing to be used without a lock nut.

These bearings are recommended for electric motors and other applications where only a locating or nominal thrust is present.

■

Robins-Jones Bearing

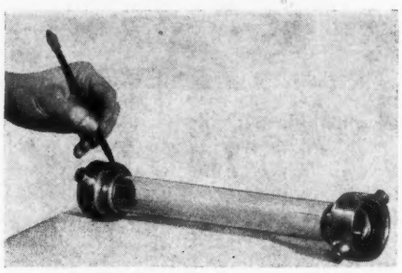
MANUFACTURING and selling rights to the Jones bearing have been purchased by The Robins Conveying Belt Company, 15 Park Row, New York, N. Y. Henceforth this product will be marketed as the Robins-Jones bearing.



■

Westinghouse Method for Soldering Glass

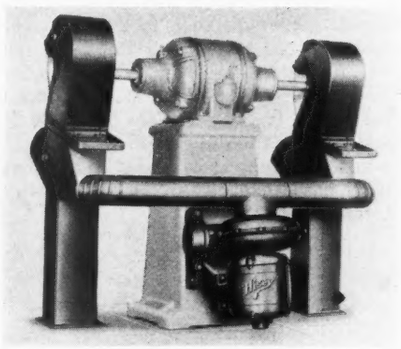
WESTINGHOUSE Electric & Manufacturing Company, East Pittsburgh, Pa., has developed a method for soldering glass that is now being used in the manufacture of sanitary glass piping. An example of this application is shown in the illustration. Solder is joined in molecular bond with a metallic glaze on the outside of the glass tube and the metal of the standard sanitary pipe fitting. The manufacturers predict that this method will be used for sanitary solder joints for windows in metal tanks, such as the mix measuring tanks for ice cream freezers, and also in joining metal bushings to the lining of glass-tube tanks.



■

Hisey-Wolf Exhauster Equipment

BALL-bearing, motor-driven exhausting equipment, shown in the accompanying illustration, is now available for use with Hisey buffing and polishing



machines, announces the Hisey-Wolf Machine Company, Cincinnati, Ohio. One automatic starter controls both motors.

■

General Electric Trip Device

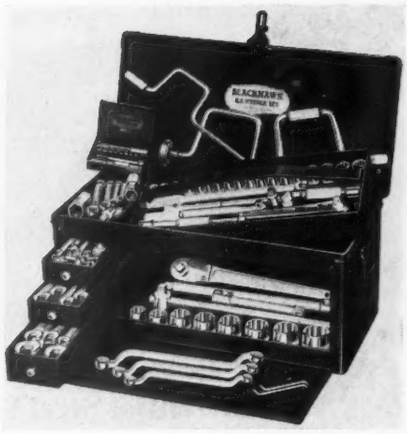
A TRIP device which can be added to the Type IAC overcurrent relay has been announced by the General Electric Company, Schenectady, N. Y. It operates instantly on heavy overcurrents and can be assembled inside the relay case. Its calibration range can be varied from 20 to 80 secondary amp. to suit service requirements. The device consists mainly of a coil connected in series with the operating coil of the relay and circuit-closing contacts for shunting relay contacts.

■

Blackhawk "Big Chief" Wrench Set

BLACKHAWK Manufacturing Company, 120 North Broadway, Milwaukee, Wis., announces a wrench set known as the "Big Chief" No. 87WD. The set consists of 87 chromium-plated wrenches with double-hexagon, chrome-vanadium sockets.

Socket sizes range from ¼ in. to 1⅝ in. Extra-small series wrenches with



¼-in. square drive, small series with ⅜-in. square drive, standard series with ½-in. square drive, and heavy-duty series with ¾-in. square drive are included in the set, as well as the engineers' tappet, and box-type tools.

The case is of black enamel and is 27 in. long, 12 in. high, and 13 in. wide.

■

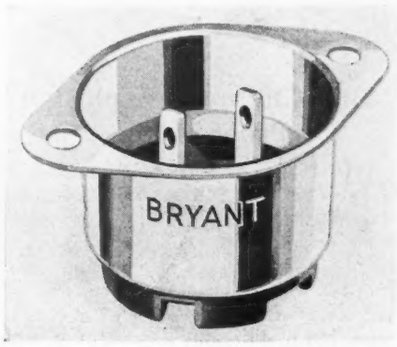
Portable Machinery Company Consolidates with A. B. Farquhar Company

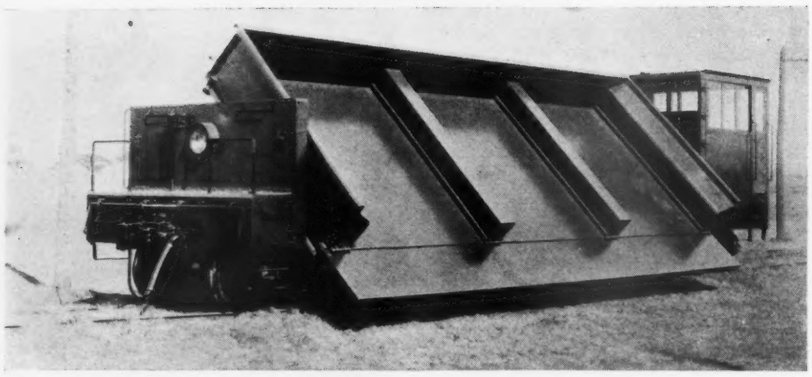
PORTABLE Machinery Company, Clifton, N. J., will in the future be operated as a division of the A. B. Farquhar Company, Ltd., York, Pa. Both companies manufacture conveying machinery. Although the main office and factory of the Portable Machinery Company will be moved to York, Pa., a branch factory and service station will be maintained at Clifton.

■

Bryant Flush Motor Plug Cap

BINDING screw terminals for back connections are incorporated in the flush motor plug cap announced by The Bryant Electric Company, Bridgeport, Conn. The cup is sufficiently large to accommodate all standard cord connector bodies.





Differential Steel Locomotive Dump Car

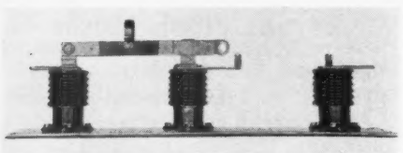
A COMBINED, self-propelled locomotive and dump car has been announced by The Differential Steel Car Company, Findlay, Ohio. It is intended primarily for mining, quarry, and industrial plant uses, such as waste disposal and car switching.

The vehicle consists of a locomotive chassis on which a dump body is mounted. It is electrically driven by four motors, the current for which is supplied by two gasoline-engine-driven generators. Air-brake equipment includes a compressor belted to each engine, giving an air capacity of 120 cu.ft. per min. Truck center-distance is 29 ft.; wheel center-distance, 5 ft. 6 in. One unit weighs 45 tons light, and 80 tons loaded. The double power plant will produce a maximum tractive effort of 36,000 lb. and a free running speed of 19 m.p.h. when the vehicle is light. The dump body has a capacity of 24 cu. yd. when level.

■ ■

Champion Disconnecting Switch and Fuse Mounting

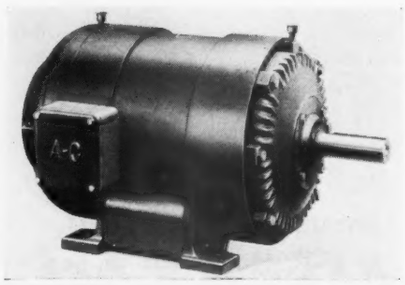
CHAMPION Switch Company, Kenova, W. Va., has developed a combination 15-kv. disconnecting switch and fuse mounting for indoor service. The blade is provided with a support for mounting a limiting resistance in series with the fuse for which clips are provided. The switch blade has a positive lock, permitting it to be stopped at any desired angle. The blade may be hinged at the center insulator.



■

Allis-Chalmers Explosion-Proof Motors

ALLIS-CHALMERS Manufacturing Company, Milwaukee, Wis., has developed a line of explosion-proof motors designed for use in hazardous atmospheres such as are encountered in oil refineries, gasoline, dry-cleaning, paint, varnish and lacquer plants. Construction of this unit is along the same general lines as the inclosed, fan-cooled type. Special features include extra-long bearing seals and alloy-steel cap screws.



■

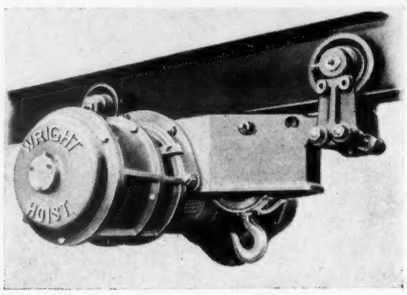
James Vertical Speed Reducer

VERTICAL speed reducers with spiral, bevel gears have been announced by the D. O. James Manufacturing Company, 1114 West Monroe St., Chicago, Ill. Gears are cut from chrome-nickel steel. Shafts are of 40-carbon steel. Roller bearings are used on both driving and driven shafts. Reducers are available in sizes from ½ to 100 hp. and in ratios from 8 to 1, to 1,600 to 1. In the larger ratios the reducers are made integral with planetary reduction units.

■

Wright Electric Hoist

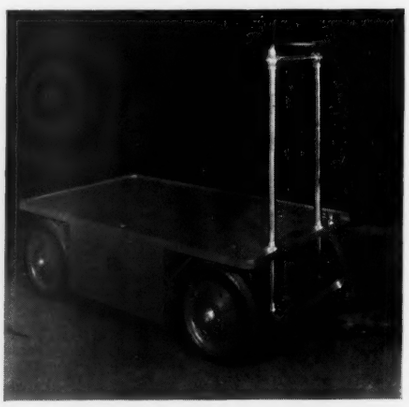
WRIGHT Manufacturing Company, Bridgeport, Conn., announces a line of hoists, known as Type WH, designed for limited headroom. The minimum distance from the bottom of the I-beam to the hook is 11 in. for the ½-ton hoist, and 13 in. for the 1-ton hoist. Features of the standard hoists, such as "True-Lay" performed cable, oil-bath lubrication, and heat-treated gears and pinions, are included in the line.



■

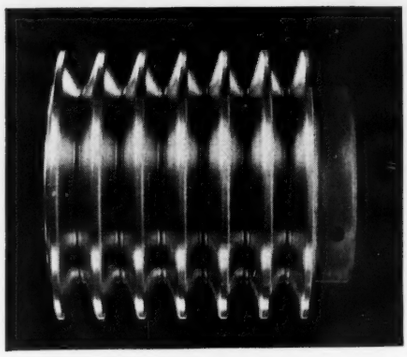
Custer Utility Trucks

UTILITY electric trucks known as Custer cars have been announced by the Custer Specialty Company, Dayton, Ohio. They are designed for all uses in industrial plants in which light and rapid deliveries are desired, such as mail delivery, and as a repair truck for the maintenance department. Trucks operate in a speed range of from 2½ to 10 m.p.h. They are available in two sizes, with 400- or 800-lb. capacity.



American "Wedgbelt"

"WEDGBELT" is the trade name given the pulleys designed for V-belt drives developed by the American Pulley Company, 4200 Wissachickon St., Philadelphia, Pa. They are particularly recommended for service as driving or motor pulleys. Grooves are constructed of pressed steel and are assembled about a cast-iron hub which may be bored and keyseated to suit requirements.

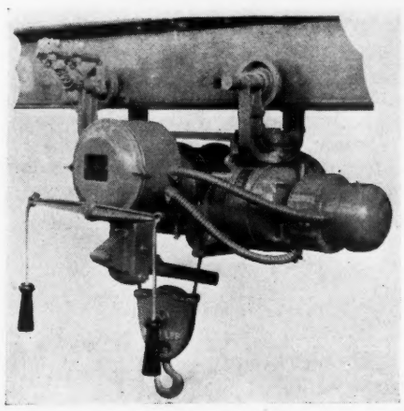


■

Sprague Hoists

SPRAGUE Electric Hoist Division of the Shepard-Niles Crane & Hoist Corporation, Montour Falls, N. Y., announces a line of hoists available in ¼- and ½-ton sizes.

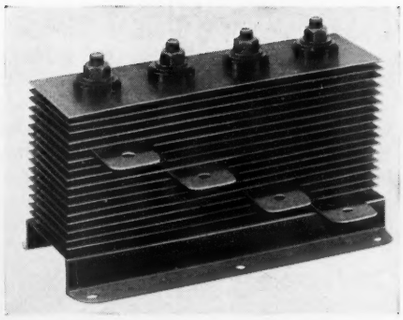
Hoists are driven by General Electric motors through worm drives and are fully inclosed. Controls may be furnished either in pendant or push-button types. Swivel trolleys with ball-bearing wheels are used. All wiring is in conduit.



■

B-L Electric Rectifiers

HEAVY-DUTY rectifiers constructed entirely of metal plates have been announced by the B-L Electric Manufacturing Company, 19th St. and Washington Ave., St. Louis, Mo. They are used to obtain low-voltage direct current from a.c. lighting or power lines and require the use of small step-down transformers for this purpose. The instruments are designed for use in signalling, alarm systems, and industrial control.

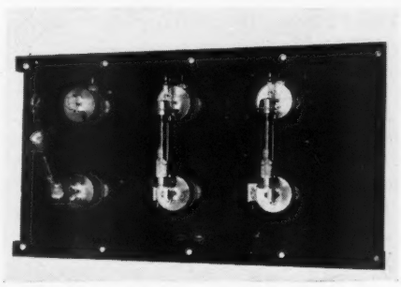


■

Delta-Star Fused Disconnects

DELTA-Star Electric Company, 2400 Block, Fulton St., Chicago, Ill., announces a unit consisting of three 15-kv., 300-amp., single-pole, locked-type, indoor-form, front-connected, disconnecting switches with an insulating section carrying high-rupturing capacity, 1-amp., potential-transformer fuses. Limiting resisting units connected in series with the fuse are mounted on the insulator units.

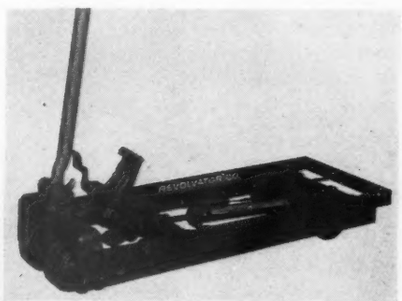
Switch locks are so arranged that, when the switch-operating stick is inserted, the lock releases, permitting opening of the blade. Insulator elements are of unit-type design and interchange with those used on bus supports and other forms of disconnect switches. The base is of steel for mounting on flat- or pipe-mounting structures.



■

Revolvator "Red Giant" Lift Trucks

REVOLVATOR Company, 336 Garfield Ave., Jersey City, N. J., announces a line of lift trucks known as "Red Giant" Model H. Standard lift is 1¾ in. Disengagement of the lifting link, when the load is lowered, prevents the handle from kicking back. Hyatt roller bearings and Alemite lubricating systems are standard. Trucks are available in capacities up to 5,000 lb. lifted by a single stroke of the handle.

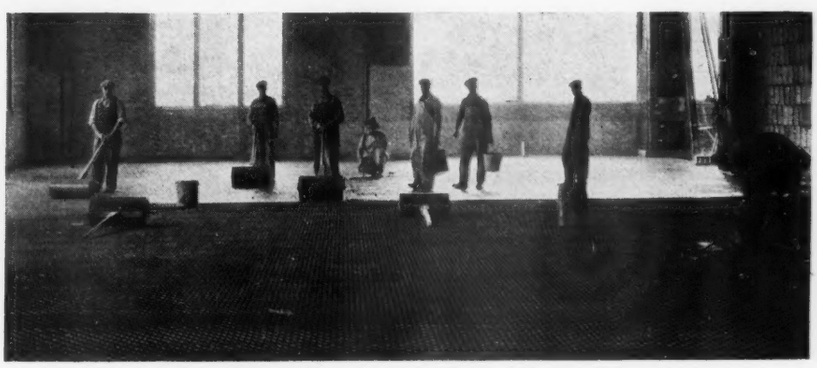


■ ■

Smith Floor Armoring

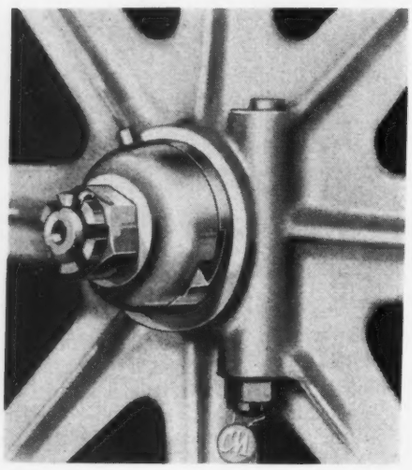
STEEL reinforcement for armoring concrete and mastic floors, known as Smithsteel "Coat of Mail," has been announced by the A. O. Smith Corporation, Milwaukee, Wis. Its principal use is in floors where traffic conditions create extreme demands for resistance to wear and shock. It is imbedded in the flooring material with rings of steel exposed flush with the floor surface.

Panels are furnished 2½ ft. wide x 8 ft. long, equivalent to 20 sq. ft. The material is 1 in. high and weighs 3.025 lb. to the square foot.



Chisholm-Moore Hoist Governor

ANNOUNCEMENT has been made by the Chisholm-Moore Hoist Corporation, Tonawanda, N. Y., of a patented, overload safety governor which may be



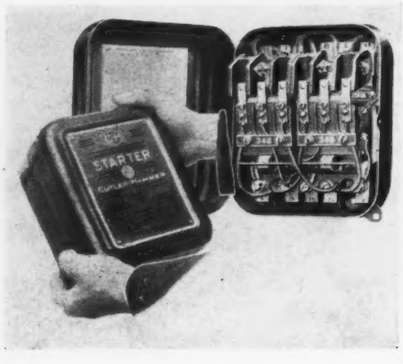
furnished as a part of its "Al-lite" line of chain hoists. The governor is said to indicate and prevent loading in excess of 50 per cent overload.

■

Cutler-Hammer Reversing Starter

DEVELOPMENT of across-the-line reversing starters for d.c. and a.c. polyphase motors up to 3 hp. is announced by Cutler-Hammer, Inc., 253 North 12th St., Milwaukee, Wis. Starters are designed for use with motors operating hoists, lifts, garage doors, small machine tools, and other applications in which half-time, intermittent duty makes their use desirable.

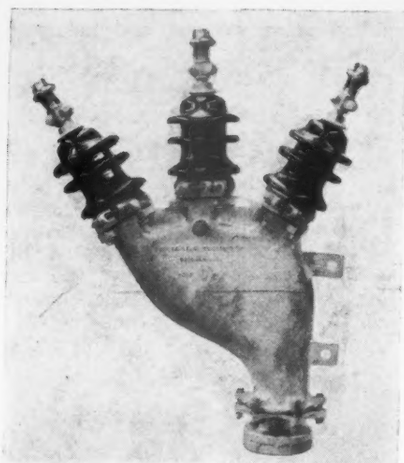
Reversing is accomplished by two mechanically interlocked magnetic contactors controlled from a remote point by a separate pushbutton master station. Contactors are of three-pole design and contacts are silver to silver. Magnet structure consists of a laminated frame with a shading coil for alternating current and a brass shield for direct current. Starters are furnished in two types: Type SRA, arranged for two-wire control only, and having a maximum capacity of 1 hp., and Type SRB, for either two- or three-wire remote control. A maximum capacity of 3 hp. is made possible by means of blowouts in the latter type.



■

Delta-Star Multiple-Conductor Terminators

MULTIPLE-CONDUCTOR terminators, with a large space factor, insuring minimuim bending of cable, have been announced by the Delta-Star Electric Company, 2400 Block Fulton



St., Chicago, Ill. This design is intended to replace the elbow shape which requires comparatively sharp bends in the cable.

■

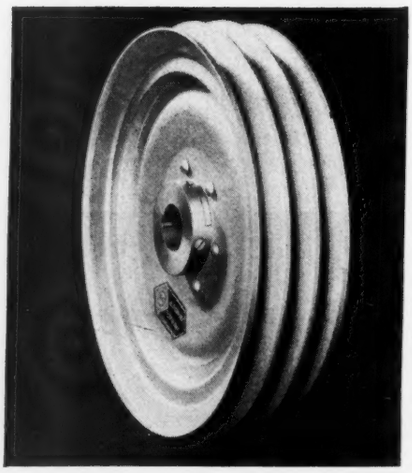
Porter-Cable-Hutchinson Dustless Floor Edger

PORTER-CABLE-HUTCHINSON Corporation, Syracuse, N. Y., announces a dustless "Take-About" floor edger. It is identical in design with the dustless bench sander with the exception of the front pulley assembly, which consists of a 1¼-in. pulley with a 5/16-in. soft-rubber tread and a small shoe located directly in back of the pulley. Although the edges come within ⅜ in. of the baseboard, the pulley is prevented from marring the woodwork by means of an adjustable bumper.

■

Allis-Chalmers "Texsteel" Sheaves

PRESSED steel sheaves, known as "Texsteel," for use in "Texrope" drives, have been developed by the Allis-Chalmers Manufacturing Company,



Milwaukee, Wis. Sheave parts are die pressed and each section is welded both at the web and at the rim. They are manufactured in a large range of diameters, permitting ratios as high as 6 to 1, and are coated with aluminum paint.

■

Wrought-Iron Welding Elbows

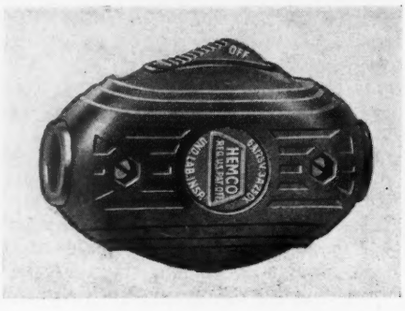
WROUGHT-IRON welding elbows known as "Weldells" have been announced jointly by The Locomotive Terminal Improvement Company, Chicago, Ill., and A. M. Byers Company, Clark Building, Pittsburgh, Pa. Weldells are available in sizes from 2 to 12 in. and are made with the same radius and center-to-face measurements as standard fittings. In forging, a tangent is formed on each end, making the units interchangeable with standard fittings. Ends are beveled 45 deg. for welding.

Stock sizes include both standard- and light-weight (10-gage) sections. Wrought-iron plate is used, with a reinforcing rib along both the outer and inner curvatures.

■

Bryant Tumbler-Type Cord Switch

CORD switch No. H271 "Hemco" has been introduced by The Bryant Electric Company, Bridgeport, Conn. The body is of brown bakelite

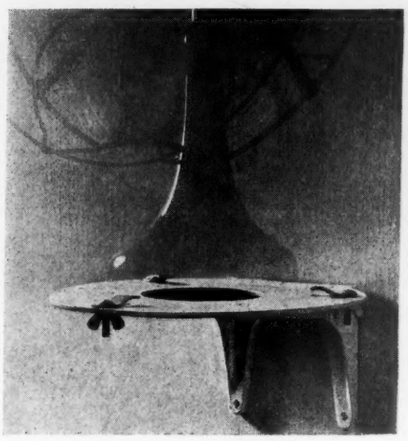


with straight-through feed so designed as to afford strain relief for the cord. The milled-edge indicating switch handle is also of brown bakelite. The manufacturer claims that the switch is almost noiseless.

■

Standard Fan Brackets

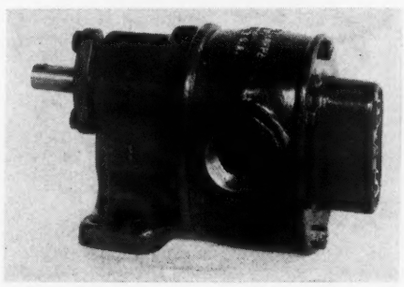
ONE-PIECE, all-metal brackets for mounting electric fans have been announced by the Standard Fan Bracket Company, 132 Essex St., Jersey City, N. J. Fans are clamped on the brackets by tightening three hand screws.



■

Brown & Sharpe Geared Pump

ANNOUNCEMENT is made by the Brown & Sharpe Manufacturing Company, Providence, R. I., that they have added a larger pump, known as No. 4, to their regular line of geared pumps. It is especially adaptable for use



as a coolant pump for machine tools or a lubricating pump for larger machinery.

Capacity is 15 gal. per min. at 500 r.p.m., with a corresponding increase of 3 gal. per min. for each 100 r.p.m. increase up to 1,000 r.p.m. Suction and discharge ports are threaded for 1¼-in. pipe. Design and construction is the same as the smaller geared pumps. All accessories available for the smaller sizes may be furnished with the exception of relief valves.

Square D Power Filter Unit

SQUARE D COMPANY, Detroit, Mich., announces a power filter unit for use in supplying direct current from a.c. sources. Although it is best adapted to telephone, talking-picture, and other sound-producing apparatus, this device has many industrial uses, chief among them being the operation of magnetic

chucks. The illustration shows a 2-amp., 24-volt unit designed for telephone operation.

■

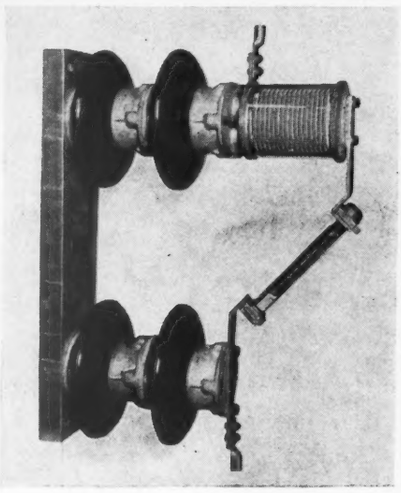
Fansteel "Tantalum"

FANSTEEL Products Company, North Chicago, Ill., announces that it has developed a process by which pipe, tubing, or fabricated parts made from "Tantalum," a corrosion-resisting metal, may be either coated or lined with a deposit of copper for strength and rigidity. Tubing made by this process may be obtained in a wide range of sizes, such as straight lengths, bends, or coils; and may be protected either inside or outside. According to the announcement, the tubing may be formed, bent, coiled, or welded without spoilage.

■

Delta-Star Outdoor Fuse Mounting

SINGLE-POLE, high-voltage, outdoor fuse units for service transformer protection have been announced by the Delta-Star Electric Company, 2400 Block, Fulton St., Chicago, Ill. The limiting resistance, in series with the fuse contact, is inclosed in a heavy glass container and mounted on the upper insulator unit. This permits the fuse to be mounted at an angle permitting easy insertion or replacement.



■■

General Electric Testing Kits

PORTABLE testing kits for checking alternating current and voltage in industrial plants have been announced by the General Electric Company, Schenectady, N. Y. Tests may be made without disconnecting leads.

The kit includes a split-core current transformer, a companion ammeter, portable voltmeter, a 10-ft. 2-circuit lead, and a leather carrying case. The transformer, ammeter, and lead form a unit and are calibrated together. Kits of various combinations can be made to suit individual requirements.

TRADE LITERATURE

For copies, address the manufacturers concerned

■

(190) PUMPS—Reference catalog, 96 pages, deep-well turbine pumps.—Layne & Bowler Corporation, 900 Santa Fe Ave., Los Angeles, Calif.

(191) STEEL EQUIPMENT—Form 435, 36 pages, "Hallowell" packing-plant equipment.—Standard Pressed Steel Company, Jenkintown, Pa.

(192) INSTRUMENTS — Bulletin 431, 6 pages, "Graphic Instruments as a Guide in the Operation of Large Machines."—The Esterline-Angus Company, Indianapolis, Ind.

(193) LIGHTNING ARRESTERS—Booklets 3 and 4 of a series, 8 pages each, "Crystal Valve" lightning arresters.—Electric Service Supplies Company, 17th and Cambria Sts., Philadelphia, Pa.

(194) VENTILATION — Catalog 377, 48 pages, Sturtevant unit ventilators.—B. F. Sturtevant Company, Inc., Hyde Park, Boston, Mass.

(195) ALLOY-STEEL CASTINGS—Bulletin, "Durimet," "Durco Nirosta" and "Special Analyses." Corrosion resistance and technical data.—The Duriron Company, Dayton, Ohio.

(196) FIRE PROTECTION — Quarterly of the National Fire Protection Association. —60 Batterymarch St., Boston, Mass.

(197) POWER TRANSMISSION — Timken Engineering Journal, 138 pages, construction, applications, fitting practices, load calculations, and other pertinent information on roller bearings.—The Timken Roller Bearing Company, Canton, Ohio.

(198) ELECTRICAL DEVICES—Bulletin 31, 8 pages, suspension devices for electrical conduit, wire and cable.—The Efficiency Electric & Manufacturing Company, East Palestine, Ohio.

(199) HEATERS — Bulletin, 12 pages "Getting Full Price for the Peaks."—Sangamo Electric Company, Springfield, Ill.

(200) CONDUIT — Folder, Youngstown buckeye conduit.—The Youngstown Sheet & Tube Company, Youngstown, Ohio.

(201) MATERIALS HANDLING—Catalog, 32 pages, a complete line of portable conveyors. — Portable Machinery Company, Clifton, N. J.

(202) ELECTRIC HEATERS—Bulletin 250, 4 pages, "Falcon" tubular electric immersion heaters.—H. O. Swoboda, Inc., 3400 Forbes St., Philadelphia, Pa.

(203) ELECTRICAL EQUIPMENT—Catalog 15, a complete description of all Trumbull products.—The Trumbull Electric Manufacturing Company, Plainville, Conn.

(204) MATERIALS HANDLING — Folder, "Porta" the under-car-unloader for coal, coke, stone, and sand.—Portable Machinery Company, Clifton, N. J.

(205) CAST IRON—Bulletin 208, "NiResist," a corrosion and heat resistant nickel-copper-chromium cast iron.—The International Nickel Company, Inc., 67 Wall St., New York, N. Y.

(206) VENTILATION—Propeller fan catalog 385, 12 pages, welded, pressed-steel propeller fans.—B. F. Sturtevant Company, Hyde Park, Boston, Mass.

(207) OIL BURNERS—Bulletin 22, "How to Install Steam Atomizing Oil Burners;" Bulletin 30, "Oil Burner Accessories;" Bulletin 50, "Oil and Gas Combustion Units;" Bulletin 60, "Indirect Rotary Oil Burners;" Bulletin 70, "Direct Rotary Oil Burners, and Oil Burning Efficiency."—National Airoil Burner Company, 1327 Girard Ave., Philadelphia, Pa.

(208) MATERIALS HANDLING — Catalog, 48 pages, electric hoists, descriptions and dimensions.—Wright Manufacturing Company, Bridgeport, Conn.

(209) CONDUIT—Folder, coated, galvanized conduit.—Youngstown Sheet & Tube Company, Youngstown, Ohio.

(210) CORROSION-RESISTING METAL — Folder, "Tantalum in the Process Industries."—Fansteel Products Company, Inc., North Chicago, Ill.

(211) AIR CONDITIONING — Bulletin 160-3, 8 pages, Coppus "Heat Killers."—Coppus Engineering Corporation, 344 Park Ave., Worcester, Mass.

(212) DIESEL ENGINES — Folder, stationary, Type JT diesel engine.—Cooper-Bessemer Corporation, Mt. Vernon, Ohio.

(213) PUMPS — Specification Sheet W-312-S4, 4 pages, Types LA and LC, single-stage volute centrifugal pumps.—Worthington Pump & Machinery Corporation, Harrison, N. J.

(214) MATERIALS HANDLING — Bulletin 1239, 12 pages, automatic and remote control dump cars.—The Atlas Car & Manufacturing Company, Cleveland, Ohio.

(215) ELECTRICAL EQUIPMENT — Bulletin 313, 64 pages, "Keystone Crystal Valve Lightning Arresters." — Electric Service Supplies Company, 17th and Cambria Sts., Philadelphia, Pa.

(216) PUMPS—Circular, geared, vane, and centrifugal pumps.—Brown & Sharpe Manufacturing Company, Providence, R. I.

(217) GENERATORS—Circular 1908, 12 pages, "Small Generator Units and Their Application." — Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa.

(218) POWER TRANSMISSION—Bulletin, 20 pages, complete "Wedgbelt" drives and simplified data for designing and ordering.—The American Pulley Company, 4200 Wissahickon Ave., Philadelphia, Pa.

(219) RELAYS—Bulletin 1021, 24 pages, "Strowger Relays and Relay Mountings." —Automatic Electric, Inc., 1033 W. Van Buren St., Chicago, Ill.

(220) CHROMIUM PLATING—Specification Sheet, S-2001-A, 12 pages, industrial chromium plating.—Worthingham Pump & Machinery Corporation, Harrison, N. J.

(221) MOTORS — Bulletin 508-A, 12 pages, explosion-proof, self-ventilated, squirrel-cage motors. — The Louis Allis Company, Milwaukee, Wis.

(222) DIESEL ENGINES — Bulletin, 16 pages, diesel engines from 150 to 1,200 hp.—Ingersoll-Rand Company, 11 Broadway, New York, N. Y.

(223) ELECTRICAL EQUIPMENT—Bulletin 1027, 24 pages, "Strowger" automatic switches and switch mountings. — Automatic Electric Inc., 1033 West Van Buren St., Chicago, Ill.

Coming Events

Electrical Maintenance Engineers—1931 Conference, Akron, Ohio, June 4 and 5, 1931. General Chairman, S. C. Hansen, 640 N. Main St., Akron, Ohio.

National Fire Protection Association—35th annual meeting, Toronto, Can. May 11 to 14, 1931. Association headquarters, 60 Batterymarch St., Boston, Mass.

National Association of Purchasing Agents—Sixteenth International Convention, Royal York Hotel, Toronto, Can., June 8 to 11, 1931. G. A. Renard, Secretary-Treasurer, 11 Park Place, New York, N. Y.

National Electric Light Association—54th convention and exhibition, Municipal Auditorium, Atlantic City, N. J., June 8 to 12, 1931. Secretary, A. Jackson Marshall, 420 Lexington Ave., New York, N. Y.

Association of Iron and Steel Electrical Engineers—Iron and Steel Exposition, Cleveland Public Auditorium Annex, Cleveland, Ohio, June 15-19, 1931. Managing Director, John F. Kelly, Empire Bldg., Pittsburgh, Pa.

American Society for Testing Materials—Annual meeting, Stevens Hotel, Chicago, Ill., June 22-26. Secretary, C. L. Warwick, 1315 Spruce St., Philadelphia, Pa.

American Institute of Electrical Engineers — Annual summer convention, Asheville, N. C., June 22-26. Secretary, F. L. Hutchinson, 33 West 39th St., New York, N. Y.

American Society of Heating and Ventilating Engineers — Semi-annual meeting, New Ocean House, Swampscott, Mass., June 22 to 26. Secretary, A. V. Hutchinson, 51 Madison Ave., New York, N. Y.

American Welding Society—Fall Meeting and Exposition, Boston, Mass., Sept. 21 to 25, 1931. Secretary, M. M. Kelly, 33 West 39th St., New York, N. Y.

National Safety Council—20th Annual Safety Congress. Chicago, Ill., Oct. 12 to 16. Headquarters, Civic Opera Building, Chicago, Ill.

Illuminating Engineering Society—Annual convention, Hotel William Penn, Pittsburgh, Pa., Oct. 13 to 16, 1931. Assistant Secretary, Frank G. Horton, 29 West 39th St., New York, N. Y.

MAINTENANCE ENGINEERING'S DATA SHEETS

An Analysis of Babbitts and Their Alloys

(Continued from the May issue)

JAMES BRINN
Chicago, Ill.

ALL babbitt should be poured in a slow, continuous stream, inasmuch as fast pouring causes air to be entrapped in the metal, while intermittent pouring results in the formation of seams. The importance of correct babbitting practice probably is not always fully realized.

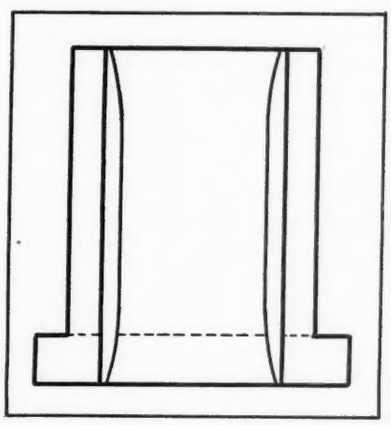
Babbitting large bearings—It is common practice in babbitting a bearing to pour the babbitt in the space between the bearing shell and the mandrel as indicated in Fig. 1. This method is not satisfactory for very large bearings because of the possibility of gas pockets being formed in the metal, and not detected until it is machined.

Agitating the metal in a mold is more or less responsible for the number of blow holes in the metal; however, in babbitting small bearings the metal is poured from a relatively low height, and there is very little agitation produced. In babbitting large bearings the babbitt is usually poured from a greater height and the splashing and agitation of the babbitt are much greater.

When the babbitt lining has been turned down to the desired thickness, the blow holes are filled in with babbitt metal by the use of a hot soldering iron, and the excess metal is then removed by machining.

It has been found that by bottom-pouring the babbitt, that is, pouring the metal through a funnel or lead which enters the mold at the bottom as in Fig. 2, only a few, if any, blow holes are formed. This method is particularly adaptable for very large bearings. As the babbitt rises when this method of pouring is used, it forces the air and gases ahead of it, so that a solid lining is formed. Removing the mandrel is not accomplished as easily as in the first method; however, this disadvantage is insignificant in comparison with the saving of time and labor and the better lining obtained.

Fig. 5—Machining a bearing so that the end diameters exceed the middle by one or two thousandths of an inch obviates the condition illustrated in Fig. 4.



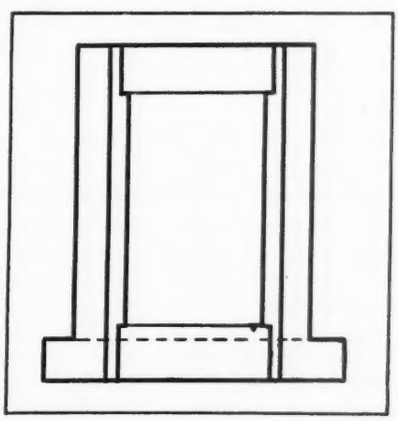


Fig. 6—Another way of reducing end friction is to machine from one to two thousandths of an inch from the lining for a distance of one or two inches from each end of the bearing.

Scraping bearings—The claim is made that the bearings have to be scraped, and that if scraping is not done subsequent trouble and failure will develop. If scraping must be resorted to it is due to one of the following causes:

1. Insufficient clearance between shaft and bearing.
2. Excessive hardness of the bearing metal resulting in its being unable to adapt itself to the shaft.

(Continued on the following page)

MAINTENANCE ENGINEERING'S DATA SHEETS

An Analysis of Babbitts and Their Alloys

(Continued from the preceding page)

It is evident that too large a clearance between shaft and bearing results in vibration and pounding, while too small a clearance causes excessive friction. Provided no undue heating occurs, the smallest clearance possible is the most advantageous, since at this point vibration is reduced to a minimum, which means that repair and maintenance are reduced and bearing life is prolonged.

As a rule friction develops near the ends of the bearing, as indicated in Fig. 3, which is the result of misalignment, This condition, Fig. 4, is illustrated with much exaggeration.

Instead of increasing the clearance between shaft and bearing over the whole length of the bearing, it is much better to machine the bearing as indicated in Fig. 5, making the clearance at the ends one or two thousandths of an inch greater than in the center. The advantages of this method are evident, and excellent results have been obtained by using it. A simpler method of machining, indicated in Fig. 6, consists in taking off one or two thousandths of an inch for a distance of one or two inches.

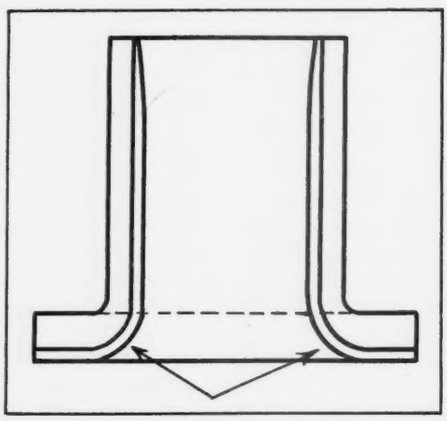


Fig. 7—Where the lining extends over the flange of a bearing tin-base babbitts should be used; otherwise cracks may form at places indicated by the arrows.

The second condition wherein scraping is necessary on account of excessive hardness and brittleness, also is easily dealt with. Where metallic friction occurs at one point and the bearing metal is too hard and brittle to yield, the friction will continue, resulting in heating and ultimate failure. Dismantling the bearing and scraping or machining off excess metal is the only remedy. If, however, the bearing metal possesses sufficient plasticity, it will yield at the point where friction occurs, since the pressure is in excess of that at the other points along the lining. Oil will flow into the space formed by the yielding of the metal, thus stopping the metal-to-metal friction.

Factors governing plasticity—Plasticity of a bearing metal is greatly influenced by its chemical composition, but the grain structure and the soundness of the metal also are of importance. Considering bearing bronzes (high lead-content alloys) the alloys containing 78 per cent copper, 7 per cent tin, and 15 per cent lead or 70 per cent copper, 5 per cent tin, and 25 per cent lead possess a higher degree of plasticity than the phosphor-bronze alloys. Where bearings are subjected to high pressures, as in rolling mills, it is advisable to use alloys of higher strength such as the alloy containing 80 per cent copper, 10 per cent tin, and 10 per cent lead, or the alloy containing 84 per cent copper, 9 per cent tin, 5 per cent lead and 2 per cent nickel.

The plasticity of babbitts is influenced by impurities such as aluminum and zinc. Lead is detrimental, which explains why some customers specify a maximum content of 0.35 per cent.

Lead-base babbitts with over 13 per cent antimony and containing from 5 to 10 per cent tin are more plastic than lead antimony alloys. Tests have been conducted with motor bearings made up of lead-antimony alloys containing 13 per cent antimony. Although satisfactory results were obtained on the test floor, trouble was experienced in the field owing to the bearings running hot. An alloy containing 8 per cent tin, 14 per cent antimoney and 78 per cent lead was substituted, and is still being used.

With regard to their plasticity, tin-base babbitts are better than lead-base babbitts. Where the babbitt extends over the flanges of bearings, as in Fig. 7, tin-base babbitts should be used.

There is no better way of determining the suitability of a babbitt than to make actual service tests. Before they are resorted to, a complete chemical analysis should be made, also the hardness, compressive strength, and resistance to hammering should be determined.